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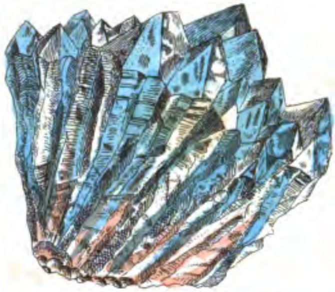
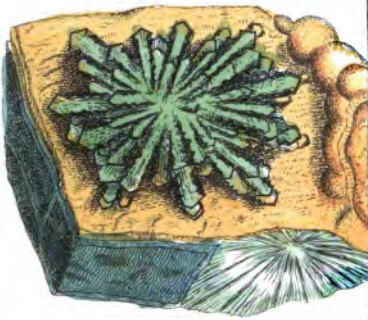
Geo Duffield Jr
1825

Geo Duffield



Coarse fibrous Amethyst.



Stellated sulphate of Barytes.

Dentritic native Copper.

Copper.

Anderson Sc

Varley, Mrs Delvalle Lowry

CONVERSATIONS

ON

T.

MINERALOGY.

BY DELVALLE LOWRY.

With Plates,

FROM THE ENGRAVINGS OF MR. AND MISS LOWRY, FROM ORIGINAL DRAWINGS.

FIRST AMERICAN FROM THE LAST LONDON EDITION.

PHILADELPHIA:

PUBLISHED AND SOLD BY URIAH HUNT,

No. 239, Market Street.

SEPT. 1822.

RECOMMENDATION.

SIR;

I have perused with much pleasure the "Conversations on Mineralogy" which you desire me to recommend, if I should approve of it.— Having had an opportunity previously, of seeing the English copy. I can truly say, that, in my opinion, few works are better calculated to excite in young persons, a love for a science, which, although comparatively low in this country; has already established its vast importance to America, in a national point of view; and which is daily augmenting the number of its admirers.

The conciseness of the work in question, and the plan adopted by its ingenious author, admirably fits it for the instruction of beginners;—nor is it wanting in interest to the more advanced lover of the science. The numerous plates from the graver of the celebrated Mr. Lowry, give it additional importance.

I trust that its republication in this country, will equally subserve your own, and the publick advantage.

I am respectfully,

your obedient servant

MR. U. HUNT. JOHN REDMAN COXE, M. D

Sept. 2d. 1822.

Gift
Tappan Presb. Ass
12-5-1931

PREFACE.

AMONG the various branches of Science and Natural History, which are so extensively pursued in this country, not one has made such rapid advances, within a short period as MINERALOGY. Although this science had been long cultivated, both in Germany and in France, it was still in its infancy, when natural Philosophy, Chemistry, and Mathematics, had attained a high degree of maturity. It has, however met with so much encouragement in England during the last twenty years, that, besides various Translations from German and French Mineralogical Works, many original Treatises on the subject have been published in this country. Of these, several have been written expressly for the instruction of young persons.

It is several years since the "Conversations on Chemistry" first appeared. The method of communicating knowledge through the medium of conversations appeared particularly well calculated for such works; and that excellent publication, under its unassuming title, exhibits, with an elegant simplicity of style, the most scientific views, and most abstruse doctrines of modern Chemistry; and has, perhaps, more than any other work, contributed to disseminate

a taste for chemical science in this country. This opinion is sufficiently confirmed by the number of editions which it has gone through. "Conversations on Chemistry" were followed by "Conversations on Political Economy," and on "Natural Philosophy," by the same Authoress. Introductions to Botany and to Algebra have appeared in the same form; and it is hoped that the present undertaking, on a somewhat similar plan, may not be found unworthy of the attention of the public.

Notwithstanding the number of elementary treatises on Mineralogy which have been published within the last few years, the mode of conversation has not yet been adopted in this branch of natural history.

It has not been by intention, in the following pages to enter into minute details, or to support any particular system, but to give my readers clear ideas of the principles of Mineralogy and Crystallography.

With respect to the latter subject, though my observations are founded on the highly ingenious and scientific theory of Haüy, a part of them, and the figures by which they are illustrated, are new; and I feel assured, that they will be found useful in explaining facts which it is often difficult for beginners to comprehend. I have said nothing of the system of Crystallography lately introduced by Professor Mohs, for two reasons; firstly, because it is merely a system of description, and does not in any degree explain the structure or formation of Crystals; secondly, because it is so abstruse, that, with-

out entering into it minutely, I fear I could not make it intelligible to my Readers; and even were I able to do so, I think they would not find a knowledge of it so practically useful, as that of Haüy's theory.

In my descriptions of Minerals, I am aware that there is little novelty; nor can much be expected from the limited plan of the work, since many of the rare minerals are necessarily passed over almost in silence. I have constantly given a much more diffuse account of the substances which are abundant or useful, than of those which are little known; and, consequently, of limited application; and I have seldom neglected to mention the purposes to which they are applied in the different arts and manufactures, or any other interesting circumstances connected with them.

My classification of Minerals differs in some respects from all that I have seen: but as it is not, to say the least, calculated to perplex the learner more than any other arrangement, I trust it will not be severely criticised: it is, perhaps, as defective as those which I have examined, and rejected because I was dissatisfied with them; for I am far from presuming that I can effect what has hitherto baffled the attempts of the most able Mineralogists and Chemists.

As it did not appear consistent with the nature of conversations, to particularize all the different synonymes of Minerals, I have inserted the principal in the Index; placing them after the English names. I have avoided as much as

possible the use of technical terms in my descriptions; but as a great many (particularly of the German school) have been generally adopted by English Mineralogists, I have endeavoured to define them clearly in the first part of the work; and near the end is an Alphabetical List of one hundred and eighty-seven names of Minerals, with their derivations from the Greek, Latin, and German. This catalogue, though far from complete, will be found interesting to the young Mineralogist, for nothing of the kind has hitherto been attempted in our language.* I feel persuaded of its being tolerably correct, as I have been favoured with the assistance of classical friends in the two former languages, and in the latter, by Mr. Heuland. To this gentleman I am also under great obligations, for the kindness with which he has constantly given me access to his splendid collection; and I am likewise much indebted to Mr. Phillips, (whose "Introduction to Mineralogy," and other elementary publications, are well known and deservedly approved,) for his great liberality in allowing me to make use of his large collection of original drawings and measurements of crystals. Nor can I omit to acknowledge the politeness of Mr. Mawe, who has frequently gratified me with the use of rare specimens and curious crystals: or the assistance I have received from Mr. König of the British Museum; and I trust they will not find the information they have afforded me, misapplied.

* I understand that a very complete work of this kind has been published *in German* by Professor Mohs, but I am not acquainted with it.

Having said thus much of the objects and pretensions of these Conversations, it will be manifest that they are intended only to *prepare* the young Mineralogist for the study of more learned treatises. But very little knowledge of Mineralogy can be obtained from books, without an acquaintance with Minerals themselves: this is unquestionably best acquired by personal instruction, which is now easily attainable through the public lectures delivered on this, as well as the other branches of Natural History in London, and in all the Universities and Colleges of Great Britain and Ireland. In London it may also be attained from the private instruction given by Mrs. Lowry, (at her house in Titchfield Street,) who has for several years devoted a great part of her time to the completion of a very extensive and valuable collection of Minerals. This circumstance, together with her knowledge of other branches of science, renders her lessons at once interesting and advantageous to her pupils; and more particularly so to ladies, who, since their attention has been invited to scientific subjects, by the establishment of public institutions equally fitted for the instruction of both sexes, have cultivated Mineralogy with great ardour.

I would recommend to persons wishing to commence this study, a small collection of Minerals, which may be had of Mr. Mawe, 149, Strand, who deals extensively in Minerals and Shells; or of Mr. G. B. Sowerby, of King Street, Covent Garden. Mr. Heuland has a large collection of magnificent specimens on sale, at his house in King Street, St. James'.

Wooden models of Crystals, (such as are occasionally spoken of in this Work,) are made by Mr. N. J. Larkin, and may be purchased of him at Gee Street, Somer's Town, or of Mr. Mawe. One or more of the following Books will also be found useful:

Introduction to Mineralogy, by Mr. Phillips, 1 vol. 12mo. 12*s*.

Introduction to Mineralogy, by Mr. Bakewell, 1 vol. 8vo. 1*l*. 1*s*.

Familiar Lessons on Mineralogy, by Mr. Mawe, 1 vol. 12mo. 6*s*.

Manuel of Mineralogy, by Mr. Aikin, 1 vol. 12mo.

When some knowledge of the subject is acquired, "A System of Mineralogy," by Professor Jameson, 2d edition, 3 vols. 8vo. 2*l*. 12*s*. 6*d*., will be found of great use, and Allan's Mineralogical Synonymes.

Mr. Mawe has also written a Treatise on Precious Stones, 1 vol. 8vo.

DELVALLE LOWRY.

CONTENTS.

Page

CONVERSATION IV.

CONVERSATION V.

CONVERSATION VI.

CONVERSATION VII.

CONVERSATION VIII.

CONVERSATION IX.

CONVERSATION X.

CONVERSATIONS

ON

MINERALOGY.

CONVERSATION I.

MRS. L.

I HOPE nothing unpleasant has detained you, for I expected you an hour ago.

Frances. Oh no, just the reverse; we have been at the British Museum, and were so much delighted that we could hardly resolve to leave it.

Mrs L. That I can easily imagine:—but what attracted your attention more particularly?

Frances. There is such a variety of interesting objects, that I scarcely know. I was puzzled which to look at first.

Mary. The minerals appeared to me more curious than any thing else.

Mrs. L. Why so?

Mary. Because I was told that they were all natural productions—and they are so very beautiful.

Mrs. L. Yes, many of them are. Do you recollect the names of any that you admired?

Mary. Yes: there are two pedestals of a green stone, called malachite, which perhaps you recollect; but I can hardly imagine that they are not artificial.

Mrs. L. I perfectly remember the substance to which you allude: it is a natural production; except that it has been

cut into the form of pedestals, and polished; and you will be surprised to hear that the greater part of it is pure copper.

Frances. Pure copper? How very strange!

Mrs. L. I can tell you many things relating to mineralogy far more strange than that. Did you not see some diamonds?

Mary. Yes; beautiful little things, very bright, and all of different forms.

Mrs. L. Well, you will hardly credit me, when I tell you that they are nothing more than charcoal.

Frances. How can that be? Diamonds are very scarce, and valuable; and charcoal is only burnt wood, which is very cheap.

Mrs. L. True: but though we cannot make diamonds by burning wood, (or in any other way,) we are certain that they *are* charcoal though not in the state in which we generally see it.

Frances. I do not exactly understand you.

Mrs. L. I will endeavour to explain myself better. Bread is made of flour, yest, salt and water: yet we are not able to convert a loaf into these ingredients. So, though chemical experiments have proved that diamonds and charcoal are essentially composed of a substance called carbon, chemistry has not discovered any operation by which charcoal may be rendered pure and crystalline. A diamond is supposed by chemists to be carbon in its purest state, and charcoal may be considered as carbon, of which the properties and appearances are altered by the admixture of so very small a portion of some foreign ingredient, that it has never been detected.

Mary. I understand you perfectly: but can you tell me why all the diamonds at the British Museum are cut into such curious forms? They are not like that in your ring.

Mrs. L. Your question is very natural; but all the diamonds you have seen, are in their original state. When minerals are found in regular geometrical or symmetrical forms, they are called crystals. Many of the other minerals that you saw, are crystallized.

Frances. I think I have heard that crystal is a kind of flint: but you say that diamonds are crystals.

Mrs. L. What is commonly called *crystal*, or rock crystal, is, as you have been told, a kind of flint. It is probably the first substance ever noticed as occurring in a regular form: the ancients believed it to be water permanently congealed by extreme cold, from its tranparency; and called it Krŭstallŏs, which means *ice;* but, in time, the word was used without attention being paid to its original meaning, and was applied to all the regular figures observed in minerals. At present, a crystal means (properly) a regular and symmetrical solid, produced by nature, or art, by the operations of chemistry.

Mary. Is glass a crystallized substance? It is very much like rock-crystal.

Mrs. L. I am afraid you will not readily understand the difference between the crystallization of glass and of the diamond. The particles of substances which crystallize, are arranged in a state of perfect regularity; and this must be the case with glass as well as diamonds, otherwise it would not be equally hard or equally transparent in every part. Common glass does not assume any regular external form; but some particular kinds, cooled very slowly, crystallize in the form of cubes.

Frances. Do all minerals crystallize?

Mrs. L. No: I could tell you the names of a great many minerals which do not; but as you do not understand mineralogy, it would be useless to you to know them. However, if you wish to learn it, I shall be very happy to give you some instruction.

Mary. I shall be very much obliged to you, if you will; for I think I should have been still more delighted with the minerals I have seen, if I had known any thing about the nature of them.

Frances. Is there any difference between mineralogy and geology?

Mrs. L. Yes; you must not confound them together. Mineralogy, in its most extensive signification, is the science of the unorganized mass of the globe; in which sense, it is divided into *Oryctognosy*, or a knowledge of minerals by their external characters; *Chemical Mineralogy*, which teaches us to distinguish them by a knowledge of their composition; and *Geology* (or Geognosy,) which makes us acquainted with the different relations of the mineral

masses, which compose what is termed the *crust of the earth.*

Mary. Do you mean that the earth is hollow, or filled with water.

Mrs. L. No: we know very little of the structure of the interior of the earth, below the depth of a mile, which is the perpendicular extent of some of the deepest mines; and compared with the diameter of the earth, is not more than the peeling of an apple in comparison with the size of that fruit. The word *crust* is certainly not scientific; but has been generally adopted by geologists, to express that outward part of the earth, with which we are acquainted.

Frances. Then oryctognosy, (which I meant when I said mineralogy,) and geology, are quite distinct from each other?

Mrs. L. By no means: geology cannot be understood without the assistance of mineralogy. For how could you describe granite, slate, or lime-stone rocks, without knowing those substances? Oryctognosy has been called the alphabet of geology; and I think the term is not misapplied.

Mary. I think I understand the connexion between them: when you have acquired a knowledge of different minerals, you explore the rocks and mines in which they are found, and study their appearance and relative situation in the earth.

Mrs. L. Exactly so.

Frances. It is also necessary to understand chemistry, to be a mineralogist; is it not?

Mrs. L. Yes: for it is chemistry which teaches us the *essential* difference between one mineral and another; that is, the difference of their composition; and without it mineralogy would be a catalogue of names, which might often be misapplied: the same denomination might be given to two or more minerals very different in their nature, if they resembled each other in appearance: and the same substance, presenting in different specimens a variety of aspects, might receive as many different names. Indeed this has frequently happened.

Mary. Then it is necessary to analyze every thing before you can give it a proper place in an arrangement.

Mrs. L. Not in the present state of mineralogy; for the greater number of substances that have been once analyzed and named, may be distinguished from each other by their external or physical characters. For example: you would never confound an emerald with a piece of marble, or a topaz with the malachite which you saw to-day. On the other hand a person who was not well acquainted with oryctognosy, would have some difficulty in detecting a piece of green fluor among several emeralds, being very nearly of the same colour.

Frances. How would you find out the difference between them?

Mrs. L. I would examine the crystallization, if any were visible, or the hardness, if I were allowed to scratch one with the other; the emerald is a great deal harder than fluor, and much less heavy. The external characters should be examined first, as it is much more easy to understand them, than to analyze a mineral.

Mary. I do not exactly know what you mean by the external characters of minerals.

Mrs. L. They are those appearances or properties which are discernible without the assistance of chemistry; and *some*, immediately by the senses, as colour, lustre, transparency, weight, taste, flexibility, and many others.

Frances. I suppose minerals are *arranged* according to their composition; though they may be often distinguished by their external characters?

Mrs. L. Such a system would be more scientific than any other, could it be rendered perfect, and has more than once been attempted; but the difficulty of analyzing minerals with sufficient accuracy; and others which arise from the imperfection of chemical knowledge, render it at present too difficult to be accomplished; and, perhaps, if it were accomplished, such a system would be, in *general*, less useful than some others; for few persons would take the trouble to become sufficiently good chemists to understand it. Nevertheless, it is desirable that it should be done.

Mary. In what manner then are minerals generally classed

Mrs. L. Before I can explain to you intelligibly the

nature of classification, you must know something of the substances of which minerals are composed.

Mary. True. I had forgotten my complete ignorance of the subject.

Mrs. L. Well then, let us begin methodically: perhaps you can define what a mineral is, or what you imagine it to be.

Mary. A mineral is a stone, is it not? or any thing that is dug out of the earth.

Mrs. L. Your first definition was tolerably correct; your second, rather too general, as it includes potatoes and carrots.

Frances. How would *you* describe a mineral?

Mrs. L. To define any thing precisely, is very difficult: it is much easier to say what it is *not*. Your sister's definition is much more concise than any I could give. A mineral seems to differ from animals and vegetables in being completely unorganized; that is, it is inanimate, and possesses none of that construction which is necessary for the support of any kind of existence, or reproduction.

Mary. Minerals do not grow, as animals and vegetables; do they?

Mrs. L. The growth of minerals is a disputed point among naturalists; and Mr. Knight, in his "Theory of the Earth," has published an account of the formation of crystals in basalt, by exposure to the air; M. Methuon has written on the growth of crystals of quartz, and many other substances. But the facts with which we are at present acquainted are too few to enable us to form a theory from them. The presence of water seems to have been necessary in these instances to their formation, and it may be supposed to produce a new arrangement of the particles, which would not take place without it. But you will be better able to understand all this, when you know something of crystallography. At present, it is necessary to explain to you the nature and properties of those elementary substances, which, united in different proportions constitute all the various minerals which are known.

Frances. Are these elementary substances very numerous?

Mrs. L. Compared with the number of minerals which their combinations produce, they are very few.

Mary. Is not water a simple substance or element ?

Mrs. L. No. It is composed of two substances, oxygen and hydrogen; these, with carbon, of which I have already spoken, sulphur, phosphorus, the earths, alkalis, metals, and the bases of some acids, constitute all the minerals with which we are acquainted.

The earths and alkalis have within a few years been discovered to consist of oxygen united to different metals; but as these have never been found in a metallic or pure state, it is more convenient in mineralogy to consider the earths themselves as *simple* substances.

Frances. I did not know there were more than one kind of earth.

Mrs. L. We are at present acquainted with ten earths, four alkalis, and thirty metals. I will give you a list of their names, with those of the bases of the acids which enter into the composition of minerals, and beg that you will learn them, that I may speak of them the next time I see you.

EARTHS.		ALKALIS.
Silica.	*Glucina.*	*Soda.*
Alumina.	*Yttria.*	*Potash.*
Lime.	*Barytes.*	*Ammonia.*
Magnesia.	*Strontian.*	*Lithia.*
Zirconia.	*Thorina.*	

METALS (MALLEABLE.)

Platina.	*Silver.*	*Tin.*
Gold.	*Copper.*	*Zinc.*
Mercury.	*Nickel.*	*Cadmium.*
Palladium.	*Iron.*	*Wodanium.*
Lead.		

BRITTLE METALS.

Tungsten.	*Molybdena.*	*Arsenic.*
Iridium.	*Uranium.*	*Titanium.*
Rhodium.	*Cerium.*	*Tellurium.*
Bismuth.	*Antimony.*	*Osmium.*

Cobalt. *Chromium.* *Selenium.*
Manganese. *Columbium.*

BASES OF ACIDS.

Fluorine, Chlorine, Nitrogen or Azote.
Boron. The base of Mellitic Acid.
Sulphur, Phosphorus, Carbon

CONVERSATION II.

MRS. L.

WELL, I hope you have not found much difficulty in committing to memory the names of mineral substances which I gave you yesterday.

Frances. No; much less than I expected.

Mrs. L. Many of them are, I suppose, entirely new to you; but in a little time you will be as familiar with them, as you are with silver, copper, and iron. I have already mentioned to you, that water is composed of oxygen and hydrogen; the former is perhaps the most abundant substance in nature, not only as it is a principal constituent of water, which covers three-fourths of the globe, but also of the earths and alkalis, and it exists in most minerals.

Mary. Does that marble contain any water?

Mrs. L. No, it does not; but in your favourite malachite, water exists in the proportion of about one-tenth of the whole mass. In the most simple state in which oxygen can be procured, it is a gas, or air, and in this form constitutes part of the atmosphere, which would be unfit for respiration without it. Most of the metals are found naturally combined with oxygen, and are then called oxydes. What is commonly called rust of iron, is the oxyde of the metal.

Frances. How does the oxygen unite with it?

Mrs. L. The rusting or oxydation of iron, is generally occasioned by the dampness of the atmosphere; the small particles of water which are suspended in it, are decomposed by the iron, which attracts the oxygen, and the hydrogen is liberated in the form of gas.

Mary. Is hydrogen found in any thing besides water?

Mrs. L. Yes; united with fluorine, it produces fluoric acid, which is a constituent of that beautiful vase of Der-

byshire spar, or fluor, whence the gas (fluorine) derives its name; combined with chlorine, it forms muriatic acid, which is abundant in many metallic minerals. Chlorine was formerly called oxymuriatic acid, from the supposition that it contained oxygen. It is called chlorine, from its green colour, which is, in Greek χλωρος, Chlōros.

Frances. What other acids are found in minerals?

Mrs. L. The boracic is one, which is composed of oxygen and boron, a substance not yet decompounded, and of which the nature is not yet entirely known: it is a scarce substance, having very seldom been found in a pure state, and only in three minerals, which are rare. Mellitic acid, the base of which is not ascertained, has only been discovered in one scarce substance, united to alumina, forming a combustible mineral.

Mary. Did not you once tell me that oil of vitriol was an acid?

Mrs. L. Yes. It is a common name for sulphuric acid, which is a compound of sulphur and oxygen, and is very abundant in the mineral kingdom; most of the earths, and occasionally some of the alkalis and metals are found united with it. The metals are frequently combined with sulphur itself, in a large proportion: most of the Cornish copper ores are sulphurets of copper.

Frances. *Sulphuret*, I suppose, means something united with sulphur: as oxyde does a substance combined with oxygen.

Mrs. L. Yes, it does; and sulphate, fluate, carbonate, and other words having the same termination, are used to express a substance, consisting of an earth, alkali, or metal, and an acid. Sulphur has been considered as a simple substance till lately; it is now suspected to be a compound of hydrogen and something else, which is not yet perfectly known. I need not tell you, that sulphur is inflammable, the experiment of lighting a match, proves that it is highly so. All the inflammable minerals which are known, (except mellite) are composed of sulphur, carbon, and hydrogen, in various proportions.

Mary. Pray, what is phosphorus?

Mrs. L. It is still more inflammable than sulphur, and is therefore generally kept in water, as it sometimes takes fire when exposed to the air.

Frances. I do not recollect seeing any at the Museum.

Mrs. L. It is never found in a pure state, but is procured artificially from bones, or any other animal matter. It resembles wax in its texture; but it becomes brownish or reddish in a short time, by absorbing oxygen from the atmosphere or water in which it remains: when it is dissolved by oxygen, it forms phosphoric acid, and in this state is united with some of the metals, and earths.

Mary. Forming, I suppose, phosphates.

Mrs. L. Yes: it is not plentiful in the mineral kingdom, and has not been discovered in any inflammable mineral. We shall now speak of the earths. You are already acquainted with the most abundant of them, silica, in the forms of flint and rock-crystal; it constitutes at least one-fourth part of the crust of the globe, being the principal component of granite, porphyry, and sandstone rocks; and many mountains consist entirely of quartz, or white flint, in which rock-crystals are often found. It has never been found in combination with any acid. Alumine is the basis of all clay rocks; and slate, which is an abundant mineral: it also exists in granite and porphyry, though not in so large a proportion as silex. It derives its name from alum, of which it is a necessary constituent; and is also called *argil*, from *argilla*, the Latin word for clay.

Frances. Has lime any other name?

Mrs. L. It has been sometimes called *calx*, which is its Latin name: the word calcareous is derived from it, and is applied to those minerals which consist principally of lime: all marbles and limestones are calcareous, consisting almost entirely of lime and carbonic acid.

Mary. Is that green marble slab, then, nearly the same substance as the limestone of which houses are built?

Mrs. L. That slab is *not* marble, but a mineral called serpentine: it contains a great deal of the earth magnesia, combined with silex, but seldom any lime, except the spots of white marble dispersed through it; and these are not essential to serpentine in general, but distinguish that kind which is commonly known by the name of *verde antico*.

Frances. Magnesia is used as a medicine: is it not?

Mrs. L. Yes: but I do not at present recollect that it is useful in any other way.

Mary. Are the other earths of great consequence?

Mrs. L. No: very far from it. Barytes, which is the most abundant of them, (though much less so than those I have mentioned to you,) has been occasionally prepared as white paint, and is sometimes useful in chemical operations. Strontian, which derives its name from a town in Scotland, where it was first found, is also used by chemists to detect the presence of carbonic acid, and is sometimes mixed with the other ingredients of fire-works, to produce a pink-coloured light. Zirconia, which is the heaviest of the earths, is very scarce; and has only been found to exist in the hyacinth, which is a precious stone, and the zirconite.

Frances. I suppose hyacinths are valuable as they are so scarce.

Mrs. L. Considered as precious stones, they are not very scarce: great numbers are brought from Ceylon; but the constituent earth, in comparison with silex, lime, or even barytes, is found in a very small proportion. The word *zirconia* is derived from Zircon, meaning *four-cornered*;* which is the name given by the Cingalese to the little four-sided crystals of hyacynth which are found in the sand of Ceylon. Glucina was first discovered in emerald, and aqua-marine, or beryl, and afterwards in two or three other rare minerals.

Mary. Has the word glucine any particular signification?

Mrs. L. Yes: it is derived from a Greek adjective γλυκυς (Glukus,) which means sweet; because, dissolved in acids, it produces sweet salts.

Frances. How can salts be sweet?

Mrs. L. Every compound of an acid, with an earth, alkali, or metal, which is soluble, in water, is called, in chemistry, a *salt*, without any regard to the taste it may possess. Alum, which you know is sour, is as much a salt as that you eat at dinner. Yttria, takes its name from

* I am indebted for this information to the late Smithson Tennant, Esq.

Ytterby, in Sweden, where it was first discovered, in a very rare mineral, called gadolinite; and lately, in some others equally rare, combined with fluoric acid.

Mary. There is one more earth, of which you have said nothing yet; thorina.

Mrs. L. It has been known so short a time, that its peculiar properties are not yet well known. It appears to differ in some respects from all the other earths, but very much resembles zirconia.

Frances. Do the earths resemble each other much in appearance?

Mrs. L. Yes: when pure they are perfectly white powders; but some of them may readily be distinguished by their different properties: lime, barytes, and Strontian have a sharp, caustic taste; and, as well as magnesia, partake of the nature of alkalis: for this reason, some chemists have called them alkaline earths. Do you recollect whether the earths are simple substances?

Mary. I think you said, that the earths and alkalis were composed of oxygen and different metals, which have never been found pure?

Mrs. L. Very right; they have so great and affinity for oxygen, that when exposed to the air, they burn, and are converted into earths or alkalis. They are, therefore, when procured, immersed in naptha, a mineral oil, which does not contain oxygen. *Silicon,* the base of silex, has been thought to resemble boron and carbon more than the metals. *Calcium,* the base of lime, has been procured, but takes fire instantly on exposure to the air, and burns with a brilliant white light; it has therefore, been impossible to investigate its nature: very little is known respecting the bases of the other earths; but they are generally supposed to be metals. In this phial, you will perceive some small pieces of a metallic substance, which is potassium, the base of potash.

Frances. I see them very plainly; they appear like silver.

Mrs. L. Take some out with a feather, and throw it into that basin of water.

Frances. What a brilliant light!

Mary. How very curious, that any thing should burn in water.

Mrs L. If you drink a little of the water, you will taste the potash, which has been produced and dissolved in it. Sodium and lithium, the bases of soda and lithia, are also too inflammable to be examined minutely: in appearance they resemble potassium. Potash has been found in about fifteen earthy minerals, but no, metallic ones: soda, in not more than twelve: and lithia, in two or three very rare substances. Ammonia, in its purest state is a gas; when diluted with water, (to which it readily unites,) it forms what is commonly termed spirit of hartshorne. Its precise nature is not yet well known; but it is suspected to consist of hydrogen, oxygen, and nitrogen.

Francis. Is nitrogen a gas?

Mrs. L. Yes: nitrogen and oxygen are the constituents of our atmosphere: united with a greater proportion of oxygen, it produces nitric acid, which, in the mineral kingdom, is found in saltpetre, or nitrate of potash.

Mary. Is there not also a vegetable alkali?

Mrs. L. Potash was formerly called vegetable alkali; because it has always been obtained by burning vegetables, in which it is very abundant. The knowledge of its existence in minerals is comparatively very recent. Ammonia was also called *animal* alkali; because it is always procured from animal matter, and *at first*, from the horns of stags and other creatures, whence the name, spirits of hartshorn.

Frances. I think I shall easily recollect what you have told me about the earths and alkalis; for the names are not all new to me.

Mary. It is fortunate, that the most useful of them are so much more plentiful than the others.

Mrs. L. Your remark proves that you have been attentive to what I have said; and I have no doubt that in a short time, you will be very fond of mineralogy, for this is the least interesting part of the study. When I have the pleasure of seeing you again, we shall say a little respecting the metals, and I will afterwards introduce you to my cabinet.

CONVERSATION III.

MARY.

I ALWAYS thought that gold was the heaviest metal; but my uncle told me this morning that platina is much heavier; is it true?

Mrs. L. Perfectly so: gold is about nineteen times as heavy as water, and platina twenty-one times: the weight of substances compared with the weight of a quantity of water of the same magnitude, is called their specific gravity, and is a very useful character for distinguishing minerals. I should says that the specific gravity of gold was nineteen, and that of platina, twenty-one.

Frances. How is that ascertained?

Mrs. L. By a very simple operation, which I will presently explain to you. Weigh the substance whose specific gravity you wish to ascertain, correctly in air, which should be done in a very delicate balance, like this. (PLATE I. fig. 1.) Then weigh the same body carefully in water; subtract this second weight from the first, and divide the first weight by the difference; the quotient will be the specific gravity.

Mary. I should like to weigh something in your balance to find out its specific gravity, and if it be a substance which you know, we shall see whether we have done it correctly.

Mrs. L. Very well: here is a piece of topaz; you will find weights in the drawer of the balance, (A, B,) and a pair of pincers to take up the small ones. The feet of the balance being screws (a, b, c, d,) you can by means of them, and the spirit levels, (C, D,) place it in a perfectly horizontal position.

Frances. The beam is steady now; I will take out the weights.

Mary. It weighs a hundred and seventeen grains.

Mrs. L. It must now be weighed in water.

Frances. Shall you put the scales in water.

Mrs. L. No; that would spoil the instrument, and be of no use: take off the scale in which you have weighed the topaz, and in its place, hang on this one of silver filligree, which, with the topaz, must be immered in a jar of water. (Fig. 2.)

Frances. Why; is that better than the brass scale?

Mrs. L. There are many reasons for preferring this: in the first place, brass is easily dissolved, and, by frequent use, its weight might, for this reason, be altered. The filligree, being less solid than the brass scale pans, moves up and down more readily in the water: and if it were not made in this form, a little motion in the water might wash out the topaz.

Mary. It does not weigh so much now it is in the water; what is the reason of that?

Mrs. L. It is because water is so much heavier than air, and supports the topaz in some degree. You see it now weighs only eighty-four grains. Subtract this from the first weight, which is to be divided by the difference (33,) and the quotient will be the specific gravity.

Frances. The quotient is three and a half.

Mrs. L. You find, then, that topaz is three and a half times as heavy as water.

Mary. I do not comprehend the reason of this operation.

Mrs. L. I am now going to explain it to you. You saw that when the topaz was immersed in water, it weighed less than it did in air, or, which is the same thing, it lost part of its weight; this loss of weight by emmersion in water, in any substance whatever, is always equal to the weight of a quantity of water of the same magnitude as that of the body immersed.

Therefore, if we weigh a body in air, we have its absolute weight, and by subtracting from it its weight in water, we have the absolute weight of an equal bulk of water; by comparing the two, we find the specific gravity of the substance: that is, the ratio of the weight of two bodies of equal magnitude, is the ratio of their specific gravity.

Frances. I understand it now, I believe: to ascertain this ratio, you divide, the weight of the body by the weight of an equal magnitude of water.

Mrs. L. Exactly so: the specific gravity of water, is to the specific gravity of the topaz, as the difference of the weight of the topaz in air and in water, is to the weight of the topaz in air. When the specific gravity of a mineral is spoken of, it is understood to be compared with the specific gravity of distilled water at the temperature of 60 degrees of Fahrenheit's thermometer. A cubic inch of gold is nineteen times as heavy as a cubic inch of distilled water at 60 degrees.

Mary. I should think this must be a very easy method of determining a mineral.

Mrs. L. It is not difficult, and is sometimes very useful: particularly in determining precious stones which it would be a pity to scratch in order to try their hardness and of which the colour and other properties appear to agree with those of another substance. But let us return to the metals; platina, which is the heaviest substance in nature, though not found in great abundance, is useful, as it does not become oxydated by exposure to the atmosphere, and is not destroyed by the intense heat of a furnace; for these reasons, crucibles and other chemical apparatus are made of it.

Frances. My uncle said, the touchhole of his gun was made of platina, because it would not rust. But gold does not rust; and why would it not do as well?

Mrs. L. There is no doubt that it would; but platina is cheaper, and therefore preferred. Platina has never been found in combination with sulphur, phosphorus, carbon, or the mineral acids; but is alloyed with small portions of palladium, iridium, rhodium, and osmium. It is so extremely ductile, that Dr. Wollaston has drawn it into wire the $\frac{1}{18750}$ part of an inch in diameter.

Mary. How could any thing of such extreme thinness be measured?

Mrs. L. That I will explain to you another time, when I tell you how it was drawn to that state of tenuity. Gold is a very beautiful metal: like platina, it has never been found otherwise than in the metallic state, either pure, or alloyed by other metals; native gold generally contains a portion of silver, and sometimes of tellurium.

Frances. What is a native metal?

Mrs. L. A metal that is found naturally in a metallic

state; the ore of platina, though not pure, is always metallic, and therefore called native; but mercury, copper, silver, and most others, are often naturally united with sulphur, carbonic, muriatic, or phosphoric acid, or oxygen; and have not the slightest metallic appearance. The word native is also applied to the earths when they are found in a state of purity. Neither gold nor platina are soluble in the mineral acids, except a mixture of nitric and muriatic acid.

Mary. I was very much surprised to see mercury arranged amongst the malleable metals; what is the reason for it?

Mrs. L. In the fluid state, in which you generally see it, it is neither malleable nor brittle: but mercury is rendered solid by freezing, and may then be flattened or extended by hammering, like gold or silver. The specific gravity of mercury is about 14; that of palladium not quite 12. Lead is more plentiful than any of these metals, and is very useful, as you know.

Frances. Yes; the water pipes are made of lead, and the frames of casement windows.

Mrs. L. The consumption of lead would be small, were it only applied to those two purposes, but it is extremely useful in the manufacture of glass, colours for painting, and many other articles of commerce; and some preparations are made use of in medicine. When pure, the specific gravity of lead is 11.3.

Mary. That is light compared with the specific gravity of platina, or even of gold; yet it is very common to say a thing is as heavy as lead.

Mrs. L. When that comparison was first made, platina, was unknown, and gold was probably much less in use than at present; lead was most likely the heaviest metal with which people were generally acquainted.

Frances. Is native lead a common substance in mineralogy?

Mrs. L. Lead has been rarely found pure; it occurs in many countries, but almost always mineralized by sulphur, oxygen, or some of the mineral acids. Silver, whose specific gravity is 10, is found in great abundance, both native and in combination with the substances that mineralize

mercury and lead. It is ductile, and very tenacious, though not in so high a degree as gold or iron.

Mary. It is not so useful as lead, I suppose?

Mrs L. That is only because it is less abundant, and therefore more valuable. Except in operations, where lead is indispensably necessary, silver might be used with greater advantage. It might also take the place of copper, and would certainly be very superior to it for all culinary vessels; for copper is soluble in almost every liquid, and is poisonous.

Frances. What is the reason, then, since the tea-kettle ad sauce-pans are made of copper, that we are not all poisoned?

Mrs. L. It is because so very small a quantity is dissolved at each time of cooking, and that is diluted with a large proportion of food. Very often, however, persons have felt ill a short time after eating green pickles, which is occasioned by the quantity of copper they contain.

Mary. Why *green* pickles, in particular?

Mrs. L. Because it is a common practice, (and I have even seen it recommended in cookery books,) to put the pickle, as soon as it is made, into a copper vessel, for several hours, that it may acquire a fine green colour; for if copper be dissolved in vinegar verdigris is produced.

Frances. What a pity that silver is not cheaper, or copper less soluble.

Mrs. L. It has, however, some advantages over silver; it is harder, more tenacious, and more elastic; and being lighter, is more convenient for utensils in common use: the specific gravity of copper does not exceed 8.

Mary. Pray, what sort of a metal is nickel? I never heard of it till I saw it in the list of metals you gave us.

Mrs. L. Nickel, like iron, and cobalt, possesses the remarkable property of being attracted by the magnet.

Frances. Are magnets ever made of it?

Mrs. L. No: it has been said by many good chemists, that nickel is capable of retaining the magnetic power, and of pointing to the north; but others affirm that, like iron it will only retain that power a very short time.

Frances. What is the reason that magnets are made of iron, if it so soon loses this property?

Mrs. L. Magnets are not made of iron, but of steel, which will retain magnetism for any length of time, and

has the power of communicating it to other bars and needles.

Mary. But is not steel a hard kind of iron.

Mrs. L. Steel is iron, hardened by a particular process: it is, in fact, a compound of iron and carbon, or carburet of iron; but as it is artificially produced, and has never been found in nature, it does not properly come under the cognizance of the mineralogist. Iron, which is the most useful, is also the most abundant of the metals; yet it has not been known so long as gold, silver, and copper.

Frances. What can be the reason of that?

Mrs. L. Probably, because it is not so easily obtained in a state of purity: for, except lately, iron has not been found in a metallic state, and now, in very small quantity: but gold has been found ever since the earliest ages, in a state of purity, or alloyed by very small quantities of other metals: silver and copper are often found native, and the ores of them are easily worked. The utility of iron, whether in the form of iron or of steel, is so well known, and the uses to which it is applied are so numerous, that it would be impossible and unnecessary to enumerate them. One of its best properties is, its extreme tenacity: an iron wire, one tenth of an inch in thickness, will support 705 pounds, without breaking. It has the advantage also of not being heavy, its specific gravity varying from 7.6 to 7.8. Tin is a useful metal, and rather lighter than iron: its specific gravity is 7.2.

Mary. Is not tin very soft?

Mrs. L. Yes: it is very little harder than lead, which is the softest of all metals.* Tin is found either in the state of an oxyde or of a sulpheret; but has not yet been discovered native. It is but a few years since zinc was first arranged with the malleable metals; for it is brittle, except when heated to a particular degree of temperature; but in this state it may be hammered or rolled into thin plates: and it is remarkable, that this is nearly the degree of heat at which brass is most brittle; brass is a combination of zinc and copper.

Frances. I was surprised at not finding brass enumerated among the metals, and thought you had forgotten it.

*Except the metals which are the basis of earths and Alkalis.

I suppose it is an artificial production, which does not occur in mineralogy.

Mrs. L. No ore of brass has been found hitherto; but it may perhaps exist. The ores of zinc are sulphurets and carbonates. In the carbonate of zinc of Derbyshire, cadmium has been found: it was first observed in an ore of zinc from Silesia, but very little is known respecting its properties. Wodanium was very lately discovered in a Hungarian mineral, which was formerly supposed to be an ore of cobalt. Its colour is bronze yellow; and it attracts the magnet. The name of wodanium is derived from Woden, or Wodan, an old Gothic divinity. All these metals possess the important property of malleability: gold, in the highest degree; one grain of it, when beaten out to its utmost extent, will cover 56 square inches: it is then called gold leaf.

Mary. How extremely thin it must be! I wonder if it could be made so thin as to become transparent?

Mrs. L. If you hold a piece of gold leaf before a strong light it appears of a green colour: silver leaf transmits a white light; and it is probable that all the other metals would be, in some degre, transparent, if they were reduced to state of sufficient tenuity. Iridium, which is the heaviest of the brittle metals, very much resembles platina in appearance, and is one of the four metals with which it is naturally alloyed: its specific gravity is 18.6.

Frances. That is very nearly the specific gravity of gold. Are all the brittle metals heavy?

Mrs. L No: one them, chrome, is lighter than any of the malleable ones. The specific gravity of chrome is 5.9.

Mary. The brittle metals can be of very trifling importance, I should think, compared with the malleable ones.

Mrs. L. They are, of course, inferior in real utility (in general;) but some of them are useful, and many, very ornamental; for instance, a very fine yellow colour is prepared from chrome, which is much valued by artists; and the green colour used in some of the French porcelain manufactories is made from this metal. Cobalt is the basis of the beautiful blue colour called smalt, and of the blue which is used for printing on porcelain. Antimony

is of still greater importance; it is an efficacious medicine, and enters in the composition of type metal; besides which, Naples yellow is made from it.

Mary. But, pray, how are all these things made? I am quite curious to know; for I seem to have been perfectly ignorant of a great many substances with which people in general must be very well acquainted.

Mrs. L. I am not surprised at your curiosity, my dear Mary, and had almost anticipated your questions; but you must excuse me from answering them at present. I wish to make you slightly acquainted with the nature of the bodies which enter into the composition of minerals, previously to your studying oryctognosy; but if you are anxious to know all their properties, their combinations, and their uses, you must study chemistry.

Mary. I should like to begin directly.

Frances. So should I—that is, if you think it will not interfere with mineralogy.

Mrs. L. On the contrary, you will find it very advantageous to you in your present pursuit. I am sorry that I am not sufficiently at leisure to give you some instruction myself in chemistry; but if you have a book, and a little apparatus, your brother will, I dare say, give you some assistance.

Frances. And what book would you recommend to us?

Mrs. L. The best introductory book that I know is "Conversations on chemistry." It was written purposely for young persons; and in so clear and perspicuous a manner, that I think you will have no difficulty in understanding it. But I must beg you to attend to the metals this morning, that we may not have to resume the subject to-morrow. Cobalt, of which I have just spoken, is of a gray colour, with a shade of red, and rather soft, though brittle: its specific gravity is 8.5. It attracts the magnet, and may be converted into a magnet, like steel. It has never been found pure; but is mostly combined with arsenic and sulphur.

Mary. Is not arsenic poisonous?

Mrs. L. So much so, that when thrown on hot coals, the fumes are very injurious to any one who smells them. Arsenic is often found in a native state, and nearly pure:

it is of a bluish white colour, like antimony, but becomes tarnished by exposure to the air, in a very short time. Native tungsten has never been discovered; but when rendered pure, by chemical operations, it appears of a light steel gray colour. It occurs in the state of an acid, united with iron and with lime.

Frances. I do not understand how a metal can exist in the state of an acid.

Mrs. L. When sulphur is united to a sufficient proportion of oxygen, sulphuric acid is produced: and in the same manner tungsten, arsenic, chrome, and molybdena, become acids. In this state they are found combined with several other metals, forming tungstates, arseniates, chromates, and molybdates: these four have been sometimes called semi-metals. Rhodium is one of the four metals which exist in the ore of platina. Its specific gravity is 11. which is nearly that of lead; it derives its name from ῥοδον (a rose,) on account of the red colour of its salts; osmium is another of these metals, so called from οσμη (odour) from the aromatic smell which its salts possess. None of these have been applied to any useful purpose, nor is it likely that they ever will be, as they are very rare, and very brittle. Manganese, in a metallic state, cannot be used, for it becomes oxydated immediately after it is procured. One of the uses of its ores, is to give a purple tinge to glass.

Mary. I have often observed glass windows that appeared of a lilac colour, when seen before a white curtain or shutter. Is that owing to manganese?

Mrs. L. Yes, it is. The specific gravity of manganese is 8.

Mary. Is tellurium a native metal?

Mrs. L. Yes; but it generally contains from 1 to 30 per cent. of gold. Titanium is a scarce metal, of which oxydes and a silicate only have been found, some of them containing iron; and it exists in some iron ores. It is so extremely difficult, almost impossible, to reduce it to a metallic state, that its specific gravity is unknown. Cerium and columbium are still more rare; and, for the same reason, their specific gravity has not yet been ascertained. Uranium is found in the state of an oxyde: it has been reduced to a metallic state, but with great difficulty, and

appears to be very brittle, and granular in its texture. Its specific gravity is about 6. Bismuth has been occasionally found native: it is not an abundant metal, but is used with lead and tin, to make fusible metal.

Frances. Are not all metals fusible in some degree?

Mrs. L. Yes, they are; but this alloy is called so, because it is so very easily melted; a heat rather less than that of boiling water being sufficient. It is used by diamond cutters to fix their diamonds in. I believe bismuth has been prepared for medicine; but certainly in very small quantities. You have now acquired some idea of all these simple substances in their pure and uncompounded state. You will soon see them united together in various proportions, and presenting a great variety of appearances. Many of the metals are *necessary* to mankind; others are considered useful and ornamental; and some are, at present, merely objects of curiosity.

Mary. Iron is of course the most useful and necessary: but which do you think deserves the second place?

Mrs. L. In England, I believe, copper is of the greatest utility after iron; but if all metals were equally abundant and cheap, silver would most probably precede it.

Frances. Why not gold or platina, since they are still less liable to be injured by liquids?

Mrs. L. This advantage would be counterbalanced by their great specific gravity, which would be very inconvenient in the utensils made of them. Tin would be preferable to silver for some purposes, even supposing them equally plentiful; because it is much lighter. Palladium, if found in sufficient quantity, would perhaps be useful, and in some respects very superior to lead, which is nearly of the same specific gravity: it is a little harder than iron. But I will endeavour to write for you, a list of the metals in the order of their utility *in England:* for you will recollect, that a Peruvian or an Indian might arrrange them very differently. I am now going to propose that you should have some knowledge of the external characters of minerals before you examine my collection; for as I do not undertake to teach you chemical mineralogy, I wish you to understand oryctognosy well. There are some chemical characters, however, which are very useful, and

very easily examined, such as the action of acids, and of the blow-pipe; and these I shall explain to you.

Frances. Though I am sure that you are giving us the best possible advice, I cannot help feeling some disappointment at being obliged to delay, even for a day, the pleasure of peeping into your cabinet. I hope the study of these external characters will not detain us very long.

Mrs. L. You need not be afraid that they will tire you: if I am not mistaken, you will find crystallography as interesting as it is useful; and you will see many specimens in which I must show you the particular characters which distinguish them and the other minerals, which possess them. Properly speaking, these should be called *physical* characters: but, in general, that term is applied only to three, which, indeed, cannot with propriety be called external; they are, magnetism, electricity, and phosphorence. But I will give you a list of all the *principal* physical characters; some mineralogists make numerous subdivisions in all of these; but I shall trouble you with them as little as possible; for I think *great minuteness* as puzzling to a learner as it is fatiguing.

Colour.	*Weight.*
Form.	*Taste.*
Lustre.	*Smell.*
Transparency.	——
Hardness.	*Magnetism.*
Flexibility	*Electricity.*
Frangibility.	*Phosphorence.*

CONVERSATION IV.

MARY.

I SUPPOSE we shall find colour the most useful of the external characters, as you have placed it at the head of the list.

Mrs. L. It is rather placed there because it is at first the most *striking* character, than on account of its superior utility.

Frances. It must be very useful however; for that alone would enable me to distinguish many substances from each other.

Mrs. L. There are few minerals that can be determined by *one* of their external characters alone; but I should like to know in what instances you think colour sufficiently distinctive.

Frances. My dear Mrs. L., could any one be so stupid as to mistake a sapphire for a ruby or a topaz?

Mrs. L. Why not?

Frances. Because sapphire is blue, ruby red, and topaz yellow: I wonder you should not have thought of that.

Mrs. L. But if I were to show you red and yellow sapphires, how would you distinguish them from the ruby and topaz.

Frances. I am afraid I should not perceive any difference between them; but I thought sapphires were always blue.

Mrs. L. You could not have chosen a more unfortunate example to prove your assertion: sapphires are found white, blue, purple, red, green, yellow, and gray; topaz is also very various in its colour; you have seen *white* topazes, as well as yellow ones; they are sold and worn under the name of nuova minas; pale blue and green ones

are not uncommon; and they are sometimes found of a fine red colour.

Mary. I am quite disappointed to hear that colour is so variable, and of so little use. I shall take care not to depend on it so much as on the other characters.

Mrs. L. In that you may perhaps be right; but I have not said that to pay attention to the colours of minerals, is as useless as you now seem to imagine; I wished to show you that you must not depend on colour *alone* to distinguish one mineral from another. It is of great importance when you have seen enough to be able to observe the very slight shades, which are often the only apparent difference between two specimens. Here are two which you would perhaps think the same substance.

Mary. I should indeed.

Frances. They are both green, at least.

Mrs. L. And both fibrous; but do you perceive no difference in the colour?

Mary. I think the colour of this is a little yellower than the other; but I see very little difference.

Mrs. L. That shade which appears to you so trifling, is to me very perceptible; and would satisfy me that this was epidote, and the other, actinolite. But nothing can be learnt without practice; you could not nett, the first time you tried, because your fingers wanted practice in that kind of work: and now your eye wants practice, before it can distinguish minute difference of colour. I would therefore recommend you to attend to the colours of minerals, without placing too much dependence on them at first; and I will point them out whenever they are characteristic of any substance. You will perceive in some minerals, changeable colours, which cannot be said to belong essentially to them, and are sometimes accidental, such as the brilliant sparks and flashes in opal, and fire marble.

Frances. But are not those flashes of light the real colours of opal? I never saw any without them.

Mrs. L. That is because you have probably seen none but *precious* opal, which is the only one of the species in which they occur; and, on that account is the only kind which is used for ornamental purposes. Those brilliant reflections are produced by numerous very small cracks, which exist naturally in precious opal; the real colour of

it is generally, bluish or yellowest white. In many other minerals, iridescent colours arise from accidental causes, and sometimes appear on the surface, as in sulphuret of antimony.

Mary. What is the meaning of iridescent?

Mrs. L. The word is derived from *iris*, the Latin name for the rainbow, and signifies the arrangement of colours in concentric circular stripes;* because they resemble the rainbow. I do not think it necessary to say more on this subject, at present; it is better understood, by examining and comparing together real specimens. External form, the second of the external characters is perhaps the most important of all; though it does not so immediately strike the eye as colour.

Frances. I hope minerals are less variable in their forms than in their colours; or I believe I shall find mineralogy very perplexing.

Mrs. L. I am sorry to see you so ready to anticipate difficulties, Frances: But I beg you will not imagine crystallography difficult, till you find it so, (which I trust you will not;) for the crystallization of minerals, is one of their most constant and invariable characters.

Mary. Does each mineral then crystallize differently?

Mrs. L. No: that is not exactly the case: some few regular forms are common to several substances; and most minerals present great variety in their crystallization. I have selected some wooden models, as well as natural crystals, which will enable you more readily to comprehend what I intend to say on the subject, than drawings, or explanation alone. You will find your knowledge of the elements of geometry very useful, as all crystals, even the most complex, are derived from simple geometrical solids.

Frances. I do not know whether I understand properly what do you mean by *deriving* one form from another.

Mrs. L. I will explain it to you by some examples; look at these crystals of carbonate of lime; they are very numerous, and apparently dissimilar; yet they all have some relation to one particular figure, from which they

* It is sometimes used to express colours arranged in a *straight* parallel stripes.

are said to be derived. This figure is called the *primitive form.*

Mary. I do not indeed see much resemblance between these crystals, except in a few specimens; here is one (fig. 8.) something like the summit of the one in your hand. (fig. 7.)

Mrs. L. But here is one (fig. 11.) very unlike both of them.

Mary. I should never have supposed that the same substance appeared in such different forms: I do not see the least similarity between them.

Mrs. L. Let us look at the models;—here is one of that which you first took up: it is an obtuse rhomb the primitive form of carbonate of lime. (fig. 3.)

Frances. Is it not a parallelopipedon?

Mrs. L. Yes; but when all the faces of a parallelopipedon are equal and similar rhombuses, it is called a rhomb; besides, we generally consider a parallelopipedon as standing upon one of its faces, but a rhomb appears most symetrical when standing on one of its summits, and and is always represented in that position, the axis being vertical: you see the summits A. and S. differ from the other solid angles, in being formed by the meeting of three equal plane angles; the others are formed by two acute, and one obtuse, plane angle. Now we will suppose such a rhomb of carbonate of lime to consist of rhombic particles; that is, of minute rhombs similar to itself, which you will easily understand by examining this model, (fig. 3.) If you divide it parallel to the face A D E F, you will reduce it to thin rhombic plates or laminæ, (fig. 4.;) if again you divide it parallel to the face C D E S, you will obtain long thin rhombic prisms, such as these, (fig. 5.) finally, by cutting it in a third direction parallel to the face A B C D, these prisms may be subdivided into little rhombs (fig. 6.) which will be in every respect similar to the original one.

Mary. I see clearly that a *wooden* rhomb may thus be proved to consist of smaller ones; but how can we be sure that this is the case with a crystal of carbonate of lime?

Mrs. L. By breaking or splitting a piece, you will find

that all the fragments are either rhombs, rhombic prisms, or rhombic laminæ; and these forms can be obtained from every crystal of this substance. If you split off laminæ of equal thickness from every face of the rhomb, you will lessen it, but without altering its form; it is the most simple of all the crystals in which carbonate of lime occurs; and on that account is considered as the primitive. If you examine this model, (fig. 8.) you will see how the figure is derived from the primitive by the deposition of laminæ on its faces. When you have removed those little caps, or shells, you will see the primitive rhomb.

Frances. How very curious!

Mary. And is it in this manner that crystals grow from one form to another?

Mrs. L. Of that we cannot be quite certain; but we shall suppose it to be the case at present; if this does not explain the manner in which crystals are produced, yet it is very convenient for elucidating their structure. You perceive that the laminæ which are placed on the rhomb, do not reach the edge of it.

Frances. No; it appears as if a row of little rhombs were left out.

Mrs. L. The same thing has taken place with regard to the other laminæ, for you see they do not extend to the edges of those on which they rest; a row of particles has been subtracted from each of them. This apparent decrease of the laminæ is called *decrement*. In this we have an example of decrement on what are called lower edges of the rhomb.

Mary. Why do you say *apparent* decrease?

Mrs. L. Because in reality, there is no decrease at all; the laminæ which touch the rhomb, are no larger than those which are farthest from it; and the crystal itself is evidently *increased* by every successive laminæ which is deposited on it. In this solid, (fig. 9.) the laminæ extend *beyond* the edges ab, bc, cd, &c, of the rhomb, while a decrement takes place on the upper edges Aa, Ac, Ae. It is by means of this decrements of the laminæ which are deposited on the primitive rhomb, that new crystals are produced, and are said to be derived from it. In both these examples the laminæ are supposed to be of the thick-

ness of one particle, and a row of the breadth of one particle is subtracted each time; these are called simple decrements.

Frances. There are other kinds of decrement then?

Mrs. L. Yes; in some cases the laminæ are of the thickness of one particle, whilst two, three, or more ranges are subtracted in breadth; in others, a single row of particles is subtracted from laminæ of the thickness of two or more particles; these are called mixed decrements, and the two kinds are distinguished into decrements in breadth and decrements in height. Can you imagine, Mary, what would be the effect of a decrement in breadth, in place of a simple decrement on the lower edges of the rhomb?

Mary. Let me see—the planes formed by the edges of these laminæ are upright, (fig. 8.) and those on opposite sides of each edge, form but one,—but if they receded from the edges of the rhomb, by greater subtractions in width, they would incline to the axis, and two planes would be formed, one above and one below every edge making an angle with each other; would there not?

Mrs. L. Yes; you have described it very well, but as here are several crystals produced by such decrements, try if you can find one; and I shall more easily know if you understand what you have said yourself.

Mary. I think this one must be produced by such a decrement, (fig. 10.)

Mrs. L. You are right—that solid is the effect of a dedrement of two ranges in breadth; it is a triangular dodecahedron, a very common form of carbonate of lime. The other crystal (fig. 9.) is called the equiaxe rhomb; because though much larger than the primitive, its axis is of the same length. There are other dodecahedrons produced by mixed decrements, one of them by a decrement of three in breadth to two in height.

Frances. That would be more obtuse, I suppose.

Mrs. L. On the contrary, it would be more acute than this; when the laminæ decrease by *one range*, a prism is formed; or, if you please, a pyramid whose axis is infinite; when the axis is shortened, the pyramid is of course more obtuse; but the ratio of 3 to 2 does not differ so much from the ratio 1 to 1, as 2 to 1 does, which is the decrement

producing that particular dodecahedron (fig. 10.) called by Haüy, the metastatic.

Frances. I see now; if the decrement were very rapid. by several ranges in breadth, the two new planes would almost coincide with the faces of the primitive.

Mrs. L. Certainly; they would. Now let us see what would be the effect of a decrement in breadth on the *upper edges* Aa, Ac, Ae, (fig. 9.) instead of the simple decrement which produced the equiaxe.

Frances. The two triangular planes, A*x* *y*, A *y* *z*, which form but one continued face in the equiaxe rhomb, would incline more on the face Aabc, and Acde, making an angle on the edge Ac, &c. we should have then six planes instead of three.

Mrs. L. Or twelve instead of six; the new crystal would be an obtuse scalene dodecahedron.

Mary. I thought there were but two kinds of dodecahedron, the pentagonal and the rhomboidal.

Mrs. L. Every solid bounded by twelve planes is a dodecahedron; this would be a triangular one.

I will show you one more example of decrement on the edges, and that, in a crystal which is not a rhomb (fig. 12.) It is a rhomboidal dodecahedron, derived from a cube.

Frances. Yes; by a simple decrement.

Mary. That is very easy to understand. Are all rhomboidal dodecahedrons produced in this manner?

Mrs. L. No; it is the primitive crystal of some substances, and in others is derived from the octahedron.

Mary. That is very curious.

Mrs. L. The laminæ are, in this case square; when derived from the octahedron, triangular (fig. 13.) You see that, in this case also, the decrement is simple, otherwise a twenty-four sided solid would result.

Frances. Yes; for at present, the two adjoining planes form but one, as in the equiaxe rhomb.

Mrs. L. Other modifications are produced by decrements round the *solid angles* of the primitive crystals; one of the simplest examples of this is the formation of the flat summit of the hexagonal prism; you see that where only *one* decrement has taken place, (fig. 7.) and that, parallel to the lower edges of the rhomb, the summit of the secondary crystal resembles the primitive; but in this solid

(fig. 11.) each summit is a single plane. Have you any idea how such a plane could arise from a decrement round the summit of the rhomb?

Frances. Not the least, at present; I should have thought that could only be formed by a successive deposition of hexagonal laminæ on each other.

Mrs. L. Suppose, in place of three complete rhombic laminæ which we have imagined to be deposited on the upper surface of the rhomb, that a particle be subtracted from each of them at the upper angle instead of covering the summit of the primitive, you would see as much of it as one of those particles. Perhaps you will understand this better, with the assistance of some models. The particles are subtracted from the laminæ, in rows, parallel to the diagonal A B (fig. 14.) The first row contains but one particle, the second two, the third three, and so on. This model (fig. 15.) represents a rhomb, and three superimposed laminæ, each diminished by one row of particles.

Mary. Surely more than three particles have been subtracted here.

Frances. I think there are six wanted to surround the summit completely.

Mrs. L. Your observation is correct, but you will see the necessity of this subtraction, if you consider that the laminæ extend *beyond* the upper edges of the rhomb, in order to prevent the formation of re-entering angles. If the laminæ were not thus extended, a channel would be formed along each of the upper edges.

Frances. I believe I understand the reason of it. There is but one particle subtracted from each lamina, considering them of the same size as the faces of the rhomb; and the channels are filled by as many particles as are necessary to form a line from *a* to *b*.

Mrs. L. Exactly so.

Mary. But why should there not be a channel on the upper edges, as well as the lower ones? or why are there any, in these models, for I see none in the real crystals.

Mrs, L. You have spoken without thinking, Mary, or you would not have asked that question. The particles of which substances are composed, are indefinitely small, and the channels which they form on the faces of secondary crystals, are imperceptible; therefore, they appear like

perfect planes; but if the laminæ did not reach beyond the *upper edges* of the rhomb, the channel would increase with every successive deposition, and the result would be such a solid as this (fig. 16.)

You see that a simple decrement round a solid angle, as well as on an edge, produces a single plane (fig. 15.*) Now, suppose that a *decrement in breadth* were to take place around the summit of the rhomb; what would happen?

Frances. There would be three planes around the summit instead of one.

Mrs. L. But tell me how they would be situated; I suppose the ranges of particles subtracted in the same direction as in fig. 15.

Frances. They would incline from the summit, on the faces of the primitive, and the prism would appear like fig. 8, except that the summit would be more obtuse.

Mrs. L. Well, that is correct; but suppose that no other decrement took place but this, and that it were to attain its limit, what would be the consequence?

Mary. Stop—I think I know; it would be an obtuse rhomb—more obtuse than the primitive.

Mrs. L. I am very glad that you have a clear idea of it, for it is a transformation not very easy to comprehend. Here is a model of it, exhibiting the laminæ, by means of which it has been derived from the primitive (fig 17.) It is more obtuse than the equiaxe, and a decrement of three to two, instead of two to one, would have produced one still more so, because the ratio is nearer to that of one to one, which produces a plane. As you seem to understand the nature of simple and mixed decrements, both on the edges and angles, I shall not detain you with them any longer; but there is another kind with which you ought to be acquainted before we leave the subject of crystallography.

Frances. Can decrement then take place on any other part of a crystal than the edges and angles?

Mrs. L. Certainly not—but we may imagine the particles to be subtracted in an order very different from that in which we have seen them in these examples. Decrements, on the edges, are produced by a subtraction parallel to those edges; decrements, round the angles,

are the effect of subtraction in the direction of the diagonals: but, in intermediary decrements, the particles are subtracted in the direction of a line which is intermediate between the diagonal and the side. This figure (fig. 18.) will render it more intelligible to you,—it represents a cube, and the side is supposed to contain twelve particles. The lines *ap*, *bq*, *cr*, are parallel to the diagonal, and are also the diagonals of the bases of the particles. The lines *aq*, *bs*, *cu*, are intermediate between the diagonal B C, and the side A C; now these lines are the diaggonals of the rectangles *A a h q*, *a b i h*, &c., or of the bases of the molecules subtracted, each consisting of two cubic particles.

Mary. I cannot very easily represent to myself the *appearance* of such a decrement, though I believe I understand what you mean.

Mrs. L. Perhaps this model, (fig. 19.) though not made to explain the particular case of which I have spoken, will give you a better idea of it.

Mary. I see that the molecules, here subtracted, each consist of six cubic ones, instead of two as in the case you mentioned.

Mrs. L. Observe that, in order to produce but *one* plane on the angle A, the molecules are subtracted in a different order, on each of the three contiguous faces. The laminæ, deposited on the upper surface (A B D C, figs, 18 and 19,) are of the thickness of three cubic particles, and the subtraction is, by one particle, in the direction A C, and by two in the direction A B. But the laminæ, applied to the face A F G C, are equal to two particles in thickness, while one is subtracted parallel to A C, and three parallel to A F. You will see this better by altering the position of the model, and considering A F G C, as the upper face. The thickness of the laminæ is in the direction of the edge A B.

Frances. And the thickness of the laminæ, on the plane A B E F, is equal to one particle in the direction A C.

Mrs. L. And in what order would the decrement take place on those faces, supposing that two particles were subtracted from the laminæ on the upper plane along the edge A B?

Frances. Let me see—the thickness of the laminæ on the plane A B E F, must be in the direction A C, and, therefore, equal to one particle;—two would be subtracted along A B, as in those on the upper face. The laminæ, on the face A C G F, will be equal to two particles in thickness, but the molecules would be of the length and breadth of one.

Mrs. L. Very right—you see that, on the plane A C G F, the decrement is not intermediary; but a decrement in height. The example which I have made use of to explain these decrements to you, does not exist in nature, but I have chosen it because it was the simplest I could think of. Though intermediary decrements frequently occur in the cube and other* platonic solids; they never take place in the manner represented by this model.

Mary. How then?

Mrs. L. The laminæ, on each face, are of the same thickness, and the particles are subtracted in symetrical order with regard to the solid angel round which the new planes are produced. A single face would result from this decrement, (fig. 19.) and the solid would be represented by fig. 20, where the angle A, appears replaced by the face *b r a*. This replacement of an angle or an edge, by *one* plane, is called truncation because it has the appearance of having been cut off: we know that this never happens in nature, but the expression is very convenient—but to return to the subject; if the decrement, along the edge A B, were similar to that along A C, we should have a plane on each, as represented by fig. 21, and we may easily imagine that if the same thing were to happen with regard to the other faces, that six planes would result. I do not know whether I have rendered it quite intelligible to you.

Mary. Oh, perfectly so—I comprehend it very well.

Frances. It appears so simple, that I think I could draw it.

Mrs. L. Pray do so; you cannot give me a better proof of having understood me.

* The platonic solids are the tetrahedron, the cube, the octahedron, the pentagonal dodecahedron or pentahedron, and the icosahedron.

Frances. Well, there is a sketch of it, Mrs. L. (fig. 22.:) is it correct?

Mrs. L. Yes; it is very well done. When an angle appears to be replaced in this manner (by more than two planes,) it is said to be acuminated; the expression is not very correct, however, as the word, which is derived from a Latin one, signifies *sharpened*; but it is correctly used, to express the replacement of a *plane* by several faces, as a solid angle is produced in this case. When an angle or edge appears to be replaced by *two planes*, we say they are bevelled: in all these cases we call the new planes the truncating, bevelling, or acuminating planes, according to their number. I am glad you can draw these things: but I should like you to make a few models also.

Mary. But, my dear Mrs. L. how can I do that? I have no saw, no planes, or chisels.

Mrs. L. But there are many substances which may be cut without assistance of any of these: for example, raw potato or turnip; or, if you dislike these, you will find cheese a good substitute.

Mary. That is very pleasant. We can study practical crystallography after dinner. I will cut out some cubes, and truncate and acuminate their angles and bevel the edges of them.

Frances. I am very anxious to know how you find out by what decrement one crystal is derived from another: for, since the faces of natural crystals are smooth, you cannot see the laminæ.

Mrs. L. I am sorry, Frances, that I cannot satisfy your curiosity. Before you can understand the answer to that question, you must know a great deal more of mathematics than you do at present. I can tell you, however, something relating to it: if we wish to ascertain any particular decrement, (suppose that which produces the metastatic dodecahedron of carbonate of lime,) we must measure the angles of the primitive and secondary crystal—I mean the angles (or edges) formed by the meeting of two adjoining planes. In the rhomb, we have two angles to measure, that formed by the planes A B C D and A D E F, and the angle formed by the meeting of the upper and lower

planes in the edge C D or D E, as well as the angle formed by the planes *a b c* and *b c s* of the dodecahedron (fig. 10.)

Mary. And how is that done?

Mrs. L. By means of an instrument called a goniometer: but I must defer explaining to you the manner of using it till the next time we meet; for it is much later, I believe than you imagine.

CONVERSATION V.

MRS. L.

I THINK you will be pleased with the subject of our conversation this morning—the goniometer. Its function is expressed by its name, which is derived from two Greek words, γωνος (gŏnŏs) an angle, and μετρεω (mĕtreo) I measure. There are two kinds of goniometer, the common and the reflective: but the latter, which was invented several years after the other, is capable of determining measurements with much greater accuracy.

Frances. Then, I suppose, that since the invention of this, the common one has not been much used?

Mrs. L. It is of course less used than formerly; but there are some cases, to which the reflecting goniometer is not applicable, as I shall show you presently. The common goniometer (fig. 23,) consists of a brass or silver semicircle, graduated into a hundred and eighty degrees, which are marked by short lines, extending from the rim to the concentric line within it; and two steel arms A B, F G, one of these is grooved or slit from *u* to *r*, except at *k*, where there is a little cross piece to give more solidity to it. By means of this slit, and the two pins *m* and *n*, you may slide the arm in the direction of the diameter of the semicircle, which passes through the points 0° and 180°. The pin *m* passes through a small piece of brass behind the arm F G, which is attached to the semicircle at N and by the bar O.

Mary. Why does not the slit in the other arm extend both ways from the centre?

Mrs. L. Because it is necessary, that when the edge *z s* cuts the semicircle in any of the lines indicating the degrees, it should be in a line with the centre. As the arms

are now fixed, a line would pass through the mark at 90°, and the centre, and along the edge *z s*; but it turns on the pin *m*, so that you can move it round to any other part of the circumference; and you can also shorten the distance from C to B by sliding the arm upwards. Now, if we wish to measure the angle of inclination of any two planes, we must measure the angle formed by two right lines perpendicular to the edge, which is their common section.

Frances. I see that; the angle formed by the two planes (fig. 3.) A D E F and A D C B, is the angle included by the lines perpendicular to the edge A D.

Mrs. L. Place the goniometer, then, so that the edges of the two arms shall touch these two planes, and be perpendicular to the line of intersection; hold it between your eye and the window, and, you will see whether the instrument is in perfect contact with the planes.

Frances. I think it touches exactly now: I cannot see any light between the goniometer and the crystal.

Mrs. L. Now look at the semicircle, and you will see the number of degrees of the angle, indicated by the edge *z s*.

Frances. It is 105 degrees.

Mrs. L. That is very nearly correct: we cannot measure with greater exactness by meansof this instrument. If the crystal had been imbedded in some foreign substance, it would have been necessary to shorten the distances C B and C F, and to remove a part of the semicircle: there is a hinge at the mark 90°, and another where the bar *o* is fixed behind the pin *m*, by means of which the part *D M* can be placed exactly behind M N: if you have measured an obtuse angle, it will be necessary to replace the part D M to find the number of degrees. Let us now look at the reflecting goniometer, which measures the smallest part of a degree with great nicety.

Mary. It appears to be a much more complex instrument than the other.

Mrs. L. At first: but the principal on which, it is constructed is very simple. A B (fig. 24.) is a graduated circle, of which *c* is the axis: this passes through the upper part of the two brass supports *p p*. To the other end of this axis, the circle *d* is attached as a handle, by which the large circle is turned: by moving this, we also move the

axis *e*, which is enclosed in the other, and, passing through the centre of the great circle, is attached to the apparatus *i*, *m*, &c.

Frances. Cannot this apparatus be moved without the assistance of the handle *d*?

Mrs. L. Yes: it can be turned by moving the circle *f*, which is fixed to its axis *e*, and this motion does not at all disturb the position of the great circle. The crystal, of which the angles are to be measured, must be attached to the cylindrical stem *o*.

Mary. How can I stick it on?

Mrs. L. With a little wax. Take care to place it so that the edge of the angle you intend to measure, shall be as horozontal as possible, and also that it shall be nearly in a line with the axis of the circles A B, *d* and *f*: but in order to adjust it exactly to this position, you will find it necessary to make use of the joint *r*, which allows the crystal to be moved up and down by means of the handle *m*: you can also turn it round, as the stem *o* passes through the tube *n*, which is connected with *i*. I have explained all these motions to you particularly, because it is essential that you should understand them well before you attempt to use the instrument.

Mary. I think I understand them perfectly: by combining them, you may move the crystal in any direction you wish.

Mrs. L. As the use of this instrument depends on the reflection of light from the planes forming the angle you wish to measure, I have chosen a fragment of carbonate of lime, because its surface is very flat, and brilliant.

Mary. I thought I was to measure the angles of the primitive crystal.

Mrs. L. Recollect, that the planes of the fragments of carbonate of lime are parrallel to the planes of the primitive, and therefore the angles are equal, and the surfaces produced by cleavage (or splitting,) are, in general, not only more brilliant than the natural faces of crystals, but have not those little inequalities which they are so seldom free from.

If you hold one of these pieces below, and very close to your eye, you will see a reflection of the window bars.

Mary. Yes: I see them very distinctly; and the chimneys of the opposite houses.

Mrs. L. You may also see them in the piece which is fixed to the goniometer, and by moving the different parts of the instrument, you must make the reflection of one of the bars coincide with the black line *v*, which I have drawn on the wainscoat between the window and the flour: but take care, first, that 180° on the great circle forms a line with *o* on the vernier.

Mary. I have made the reflection of one of the bars coincide with the black line.

Mrs. L. Keeping your eye fixed, turn the circle *d* till you see the reflection of the same bar in the adjoining plane, precisely on the black line.

Mary. The reflection in this plane is not quite horizontal. What must I do?

Mrs. L. Move the little circle *m* till you make the reflection coincide with the black line; then turn the great circle, and see whether the reflection in the first plane is still horizontal; if not, adjust it again whilst in that situation, and repeat this operation till it is correct.

Mary. That is very tedious; but I suppose there is no quicker method of doing it?

Mrs. L. When you are a little more used to it, you will do it in a very short time. Now, observe whether 180° on the great circle coincides with 0°; if it does not, turn it a little.

Mary. I have done so; but now I cannot see the reflection in the first plane.

Mrs. L. Never mind, you have only to turn the circle *f* till you see the reflection again, then move the great circle till you see it in the second plane: if you have performed the operation correctly, you will find the angle formed by the meeting of the two planes, 105°, 5′.

Mary. See, I have done it very exactly.

Mrs. L. Yes, you have. Now, I wish you would endeavour to explain why the reflection of a fixed object from the two planes, gives the angle of their meeting with such precision.

Mary. I am afraid, Mrs. L., that such an attempt would detain you all the morning; and, as Frances has not

used the instrument, I am sure she would not understand my bad explanation.

Mrs. L. I will show you, then. Let *a b c* (Pl. II., fig. 25.) represent a primitive rhomb, or fragment, of carbonate of lime; and *a b*, *b c*, imaginary lines, perpendicular to the line of intersection: looking on the plane *a b*, you see the image *q* of the chimney *h*, inverted on the black line; then, if you turn the crystal till you see the reflection in the plane *b c*, it must move through the space *g d*, which is the supplement of the angle *a b c*, because the line *f g* must come to the position of *e d*.

Mary. That is very evident; but if it only moves through the angle *d b g*, which is acute, what is the reason that the index points to 105° 5′.

Mrs. L. Because the circle is graduated from 0° to 180, from *d* towards *f* and *e*, and from 0° towards *g* and *d*.

Frances. I like this instrument very much; it is so accurate, and the construction of it is so simple.

Mrs. L. It is a valuable addition to the apparatus of a mineralogist, for which we are indebted to Dr. Wollaston. Minerals, which do not crystallize, occur in various external forms, some of which are very characteristic of particular species, such as the botryoidal form of calcedony and malachite.

Frances. What is the meaning of botryoidal?

Mrs. L. Having the form of a bunch of grapes. Some present a dentiform or tooth-like appearance; and others are aborescent or dendritic, that is, appearing like the branches of trees, or moss; but I can explain all these forms much better when I show you the substances in which they occur.

Transparency is a property not possessed by all minerals: some are semitransparent, as cornelian and some kinds of obsidian; some are only translucent.

Mary. Does not that mean nearly opake?

Mrs. L. Yes, it does: a few minerals become more transparent by immersion in water; which is the case with a kind of opal, called hydrophane.

It is of the greatest consequence to observe the fresh fracture of a mineral; that is, the appearance of a fresh-broken part; because it is perfectly clean, and you can better observe the form and lustre which are peculiar to it,

than in a part which has been exposed to the weather, or otherwise injured by external causes: but observe, that when I speak of the different kinds of *fracture*, I do not include under that term *cleavage*, which is peculiar to some crystallized minerals.

Frances. Are not all minerals which crystallize capable of division by cleavage?

Mrs. L. In some crystallized minerals, the cleavage is obtained with such difficulty, that were not the primitive form known, it might be doubted whether they possessed a cleavage; in such substances the fracture is generally conchoidal.

Mary. What sort of fracture is that?

Mrs. L. The word conchoidal means, literally, having the forms of a shell; but as that expresses nothing precise, I should say, that a conchoidal fracture very much resembles the form of a muscle shell. I mentioned that it is exceedingly difficult to obtain the cleavage of some minerals, as spinal ruby, zircon, and quartz: on the contrary, there are substances which divide so readily, parallel to the primitive form, that it is difficult in *them*, to produce a fracture; such are sulphate of barytes, diamond, carbonate, and fluate of lime; a specimen of any of these having a conchoidal fracture, is valuable to a collector.

You must not expect always to find a *perfect* conchoidal fracture; it is very often confused and irregular. The form of the fracture varies with the texture of the mineral: in those which are compact, it is even, conchoidal, splintery, uneven, earthy, or hackly: the last kind is peculiar to the native metals; and you may see it by breaking a piece of silver or copper wire: common chalk and fuller's earth are good and familiar examples of earthy fracture.

Frances. What do you mean by an *uneven* fracture? because I should have thought the two kinds you have just mentioned were uneven?

Mrs. L. They are so: but their appearance is better expressed by the terms hackly and earthy, and neither of these could be applied to the kind of fracture which we call uneven; the fracture of copper pyrites is generally uneven. The fibrous fracture, exhibited by some minerals, may be considered as the effect of their structure;

this appearance is frequently produced by imperfect crystallization, as in some varieties of zeolite and sulphuret of antimony, where the terminations of the crystals are often plainly observable on the exterior of the mass; but this is not always the case, for amianth and asbestus always consist of a number of delicate silky fibres, without any appearance of crystallization. A multitude of small acicular crystals sometimes diverge from a point as a centre; and when the aggregate mass is broken, it presents a fracture which is called radiated; the most beautiful example of this kind, which I can recollect, is wavellite.

Mary. I do not exactly know what is meant by an acicular crystal.

Mrs. L. In the form of a needle—all crystals, which are very thin in proportion to their length, are called acicular.

Frances. I believe *lustre* is the next of the external characters.—Is it an important one?

Mrs. L. Yes. In some minerals, where the colour and form of the fracture are the same, the lustre is a distinctive character as in blood-stone and green jasper. The principal kinds of lustre are the adamantine, the vitreous, the oily, the resinous, and the pearly—and the metallic lustre which is peculiar to some metallic minerals, and is always accompanied by the property of opacity.

Mary Is the adamantine lustre peculiar to the diamond?

Mrs. L. Not exclusively.—White carbonate of lead possesses this kind of brilliancy.

I need scarcely explain to you the meaning of the other terms, as their relation to well-known substances is obvious. The fracture of quartz is generally vitreous; the zircons and hyacinths of Ceylon have a remarkably oily lustre; the lustre of pitchstone and semi-opal is resinous, and sulphate of lime (selenite) has, in general, a beautifully pearly appearance.

Frances. I do not think I should ever confound these different kinds, they appear to be very distinct.

Mrs. L. You will soon have an opportunity of exercising your discernment; but you will not always find it easy to know to which kind you should refer the character of a specimen. You will find some in which the lustre is *intermediate* between two kinds, as quartz, in which the

vitreous lustre often approaches to oily. We must also observe the *degree*, as well as the kind of lustre—thus, the highest degree of brilliancy is called splendent; and we descend through the various degrees shining, glistening, and glimmering, till we arrive at that which is called *dull*, and is to be observed in most of those minerals of which the fracture is earthy. Each of these, like the other characters of the fracture, may be so qualified as to express intermediate degrees. We say the lustre is strongly, or faintly, glimmering; passing into dull or intermediate between glimmering or glistening; but these nice distinctions are not often necessary, unless in describing a newly discovered substance.

Mary. I should imagine hardness to be a useful character in discovering the nature of a mineral; because it can so easily be tried.

Mrs. L. You are right. Hardness a very unvarying property in most simple minerals. It is curious, however, that, in crystallized substances, the edges and solid angles of the crystals *appear* to be harder than their faces.

Frances. That is very singular—how do you account for it?

Mrs. L. There are two reasons for this apparent difference: firstly, an angular point will scratch a mineral much more readily than a flat surface can—and, secondly, it is more difficult in crystalline minerals to produce a fracture by breaking off a point than to split it into the direction of the cleavage. It is for this reason that the diamond cutters distinguish the angles of a dodecahedral crystal into *hard* and *soft* points—those which are also the angles of the primitive octahedron, they call hard points, because they cannot split or break them off, and are obliged to rub them down with diamond powder; but they remove the low triangular pyramids which form the other points, by cleavage.

Mary. Then, if I want to try the hardness of a mineral, whose name I do not know, I must try whether it will scratch, and whether it can be scratched by one which I *do* know.

Mrs. L. Certainly; but I advise you not to make a point of scratching all minerals with which you are unac-

quainted, for you may meet with some which, though hard, are brittle, and by too much pressure, you will inevitably destroy them; therefore you must be careful not to mistake hardness for tenacity, or frangibility for softness.

Frances. Frangibility is the degree of ease with which a mineral may be broken, I believe?

Mrs. L. Yes, it is. Some hard substances are very frangible or brittle, as enclase and anthophyllite; others, which are very soft, are extremely tough or tenacious; of this I cannot give you a better example than asbestus, or amianth. These two minerals are also flexible.

Mary. Is there any difference in the meaning of flexible and elastic?

Mrs. L. Yes, a good deal. Every thing is flexible that is capable of being bent without breaking; but a mineral which, after it is bent, springs back to its original form, is elastic. Mica is elastic, but talc, which very much resembles it, is only flexible. The minerals which possess the property of adhesiveness, are very few.

Frances. I do not exactly understand how a mineral can be adhesive.

Mrs. L. They adhere to the tongue when applied to it; adhesive slate derives its name from this circumstance. You will perceive the same thing in most species of clay, though not in so high a degree. The nature of specific gravity I have already explained to you, and the utility of determining it. *Taste* is confined to the saline minerals, which are soluble in water, such as muriate of soda (or rock salt) and alum; it is a property possessed by comparatively few substances. Those which emit any odour are, perhaps, not more numerous. Some minerals have a particularly disagreeable odour when rubbed. There is a kind of black limestone which, on account of this property, is called *stink-stone.* Others have a faintly sulphurous smell, which you may perceive by rubbing together two pieces of quartz.

Mary. I recollect rubbing together some white pebbles once in the dark, to see the light which was produced, and they smelt like sulphur.

Mrs. L. They were quartz pepples, and the light which you saw was phosphorescent.

Mary. Do they contain phosphorus?

Mrs. L. No; but that kind of light is so called from its resemblance to the light emitted by phosphorus.* Some minerals become phosphorescent when heated, which is the case with most species of fluor, and a few kinds of carbonate of lime. Electricity is a character with which you are already acquainted.

Frances. Yes, I remember you have told me that amber is electric—when it is rubbed it attracts small pieces of thin paper and bits of cotton.

Mrs. L. A great many substances are electric when rubbed, but in a *few* this property is excited by heating them. You recollect, perhaps, that there are two kinds of electricity, called positive and negative; the one produced by the friction of glass, the other by rubbing any resinous substance, such as a stick of sealing wax, which, on account of its form, is convenient for making an experiment. When this property is excited in a mineral, by *heating* it, it acquires electic poles, that is, positive electricity will appear on one part, and negative electricity on the part which is opposite.

Mary. That is a very curious property; how is it determined?

Mrs. L. By means of a little instrument, called an electromoter, which you shall see (Pl. III. fig. 26.) It consists of a glass stem *a*, which is fixed in a small wooden base *b*, and to the end *c*, a very small piece of gold paper *d*, is attached by means of a silk thread. You must hold the mineral in a pair of pincers *d*, of which the handle is glass, and warm it over a candle.

Frances. Why is the handle of the pincers, glass?

Mrs. L. Because glass is a non-conductor of electricity; that is, electricity will not pass through it. Here is a crystal of tourmaline, a substance in which electricity is very easily excited—if, when it is warm, you present one end of it to the gold paper, it will attract it.

Mary. Yes, I see it lifts it up.

Mrs. L. But if you shake it off, and again present the same end, it will repel the paper.

* Emitted by combustion at the common temperature of the air.

Mary. So it does—the paper flies to the distance of an inch from it.

Mrs. L. Now the other end will attract it.

Frances. I believe I know the reason of that—is it not because the electricity is of a different kind in the two ends of the tourmaline?

Mrs. L. Yes; two substances, possessing the same kind of electricity, mutually repel each other, as you saw when you presented to the gold paper, the end with which you had charged it; but the other end, having a different kind, immediately attracted it.

Mary. But, how do you find out which end is positively, or negatively, elctrified?

Mrs. L. By charging the gold paper with either kind, and then trying which end of the tourmaline will attract it.

Frances. I should like to find that out.

Mrs. L. Very well—rub the stick of sealing-wax to excite it, and touch the gold paper with it. You will find the green table cloth a better substance to rub it on than your sleeve because the friction will be greater.

Frances. This is the positive end, Mrs. L.; it attracts the paper.

Mrs. L. Charge the paper again, and try the other end.

Frances. How is this; are both ends become positively electric?

Mrs. L. No; but, in substances in which electricity is produced by exposure to heat, the poles change places during the time of cooling.

Mary. But, is that always the case?

Mrs. L. I believe it is. There are so few minerals on which electricity can be excited by heat, that it is a curious, rather than a useful character. But I must observe to you a very singular circumstance attending those which do possess it. In most substances, crystallization takes place with perfect symmetry; whatever decrement produces a plane on one angle of the primitive form, will also produce one on every similar angle; and in the cube and octahedron, where all the angles and all the edges are similar, they are all similarly affected (as in Pl. I. fig. 12 and 13.)—but in the minerals, which become electric by heating, the two points where the different kinds of electri-

F

city reside, are differently crystallized. If you examine the tourmaline, on which you have been experimenting, you will see that the two terminations are different.

Frances. Yes; there are six planes at one end, and only three at the other. (Pl. IV. fig. 65.)

Mrs. L. Borate of magnesia is a still more curious example of this formation, for, though the primitive form is a cube, only four alternate angles are modified. (fig. 237.)

Mary. But, is there not a kind of regularity in the crystals of this substance, with regard to the position of the modified angles?

Mrs. L. Yes. You will find that, of the four angles which belong to each square surface—two are modified, and two are not; those which are unaltered, being placed, at equal distances from each other, and alternating with those which are modified. You must be careful in making this experiment not to smoke the mineral by holding it over the candle; because, if it be a substance in which electricity is not produced by heat, you may excite it by the friction occasioned in wiping it. You must also take care not to make it too warm.

Frances. Would that lessen the degree of electricity?

Mrs. L. Above a certain degree of heat, the electric property gradually decreases, till it disappears entirely, and, if you still continue to augment the temperature, the poles will be changed as in cooling.

Mary. I am sorry electricity is not more useful; what you have told me appears so curious—is magnetism a useful character?

Mrs. L. Not very often; but it is a property easily examined by means of a polar magnet.

Frances. Is that different from a common magnet?

Mrs. L. Yes; the polar magnet is a small bar of magnetic steel *a*, (Pl. III. fig. 27.) which is suspended on a pin, so as to turn with the greatest ease; and, when left at rest, it always points toward the north.

Mary. This, then, is the magnet used in ships.

Mrs. L. It is exactly the same kind of thing; the two ends of the bar are called the north and south poles, and, in this respect, magnetism resembles electricity, for the north poles of two magnets will repel each other, and so

will the two south poles; but the south and north poles will attract each other. Many substances will attract either end of the magnet to which they are presented,— such as magnetic pyrites, and those minerals which contain a large portion of iron; but some ores of iron possess polarity, that is, the power of attracting and repelling the other of the poles.

Frances. I had no idea that iron existed in so large a quantity as to attract a magnet, except in iron ores.

Mrs. L. Wedgewood's black ware, which is made of basalt, attracts it very strongly; but the quantity of iron contained in some minerals is so small, that it is necessary to place the magnet differently, in order that it may move still more readily. This is done by making the north pole (A) of the bar (fig. 28.) point either to the east or west, by means of the attraction of a stronger magnet (B) you must move this magnet (B) till you find that the attraction is just sufficient to keep the polar one in the position required. Now, if any substance containing iron, be brought near it, you will find it an extremely delicate test.

Mary. What can I try?

Mrs. L. I dare say this fragment of actinolite will have some effect on it, though, perhaps, it would not in the usual way of making the experiment.

Mary. Yes, it moves it a little; but very slowly.

Mrs. L. But you see that, as the magnet returns to its natural position, it moves rather more quickly. The reason of this is obvious; the magnet has a constant tendency to point to the north and south, and a substance, containing so small a portion of iron, would not have sufficient attraction to overcome that tendency; but, when the attraction of the pole and the magnet B. are very nearly equal, the slightest attraction, in addition to that of the pole, will cause it to return to its former situation.

Mary. Yes, I see that clearly.

Mrs. L. Now, if you like, I will show you how to use the blowpipe.

Frances. That is a chemical instrument is it not?

Mrs. L. Yes; and it is very useful to a mineralogist.

Frances. Do you analyze minerals with it?

Mrs. L. That is not the object in using the blowpipe,

though many substances may be partially decomposed by it. It is a tube of metal, used to direct and concentrate the flame of a lamp or candle, so as to produce a greater degree of heat, which is done by forcing a continued stream of air against the flame.

Mary. But would not the air extinguish the light?

Mrs. L. Not when the air passes through a very small aperture, as in the blowpipe. A great many blowpipes have been invented, some of which supply the flame with a stream of atmospheric air, with oxygen, or an inflammable gas, such as the vapour of boiling alcohol, but all these have their disadvantages for a mineralogist; the greatest heat is produced by the action of Dr. Clarke's blowpipe, which supplies the flame with a current of oxygen and hydrogen, previously condensed;* it is so intense, that it melts all substances.

Oxygen also produces intense heat, but as the minerals when exposed to these, melt almost immediately, you cannot see any of the previous changes which take place in a lower degree of heat, and which should always be observed. Inflammable vapour produces a large flame, but wavering and unsteady, which is not sufficiently intense for most purposes; and common air, as well as these, must be furnished by some mechanical contrivance, which is always more or less cumbrous, and not portable, as the apparatus of a mineralogist ought to be.

Frances. Then what kind of air is generally used?

Mrs. L. It is found that air which has been *once* breathed, produces very nearly the same effect as atmospheric air; therefore, with a portable blowpipe, the stream may be supplied from the mouth; a circumstance which greatly contributes to the utility of this instrument.

Mary. Is it easy to use?

Mrs. L. It requires some practice to be able to produce a constant and equal stream of air; you should acquire the habit, not only of breathing through your nos-

* For a particular description of this instrument (which is more valuable to the chemist than to the mineralogist) the reader is referred to a pamphlet written on the subject by Dr. Clarke, of Cambridge.

trils easily, so that the current of air may not be interrupted by taking breath, but of doing so when your mouth and cheeks are inflated by air. When you can do this, you will find little difficulty in using the blowpipe, provided you do not attempt to work too hard.

Frances. Are both these blowpipes (figs. 29 and 30.) to be supplied in this manner with air?

Mrs. L. Yes; the principal difference of them is the addition of this hollow cylinder *c*, (fig. 29.) for collecting and retaining the moisture of the breath, which is here condensed. The other, called Dr. Wollaston's blowpipe, has not this cavity, but it is still more portable: being made in three pieces, which when fitted thus, (fig. 30.) are air-tight, but by putting this tube (*b* fig. 31.) within the other, and using the nozzle as a stopper, it may be packed in a very small compass, and is convenient for travelling. If you will light that candle, you shall see the manner of conducting an experiment.

Mary. Would not a lamp be better.

Mrs. L. No; a wax candle is found to be, upon the whole, the best adapted to this purpose. Before I begin, I bend the wick a *very little* from the blast of the pipe.

Frances. How steady and clear the frame is.

Mrs. L. Observe, that the flame when thus acted on, consists of two conical parts, the one contained in the other: the outer one is of a yellowish white colour, the other pale blue; and the greatest heat is just at the point of the blue flame.

Mary. But on what do you support the mineral which is to be exposed to the flame?

Mrs. L. There are several substances which may be used as supports, according to the nature of the mineral to be experimented on. Charcoal is chiefly used for the reduction of metallic ores: and it should be a sound, close-grained piece; otherwise in the middle of an experiment, the melted globule may disappear in a rift or crack.

Frances. But would not some other, more solid and incombustible substance, answer better.

Mrs. L. Not in all cases. It is easy to make a little hollow in the charcoal, in which the ore may be convenient-

ly placed; but for examining earthy minerals, we generally make use of small strips of leaf platina.

Mary. Why is that the best metal for the purpose?

Mrs. L. Because it is the most infusible of all metals, and transmits heat to a less distance than any other, so that you may hold one end in your fingers, while the other is exposed to the action of the blowpipe, without inconvenience; for some metallic minerals which are not very fusible, a small pair of platina forceps will be found useful, but when fluxes are to be used, leaf platina must be resorted to.

Frances. Pray what are fluxes?

Mrs. L. They are substances, principally used with the metallic minerals, for the purpose of dissolving the earthy matter with which the oxydes are combined; and they furnish a body, in itself nearly colourless, but to which colour will be communicated by the oxydated metal, As an example, I will mix with the flux, which is borax, a small piece of the ore of cobalt.

Mary. Will that quantity be sufficient?

Mrs. L. I am only afraid I have too much; for the colour of the metallic oxydes is so intense, that in general a piece the size of a very small pin's head is quite enough; if the quantity be too great, the result will be a glass apparently black.

Mary. I see you do not at first expose it to the hottest part of the flame.

Frances. How the borax boils and crackles!

Mrs. L. It would have been better to use glass of borax as it is called, which is borax deprived of the water it generally contains, by heat, and has the appearance of glass.

Mary. Now there is a white smoke rising from it.

Mrs. L. That is occasioned by the arsenic it contains; the smell of this vapour is very characteristic of arsenic.

Frances. It is very disagreeable.

Mary. It smells exactly like garlic.

Mrs. L. Now my experiment is finished.

Mary. The cobalt has tinged the glass with a beautiful blue.

Mrs. L. By this simple operation, you may always detect the presence of cobalt and arsenic, and of many other substances; but it is not necessary at present to explain to you the effect produced by the blowpipe on several other metals which may be discovered in the same manner.

Frances. This is a delightful experiment, it is so simple and so easily managed; and the result so satisfactory.

Mrs. L. I would advise you, if you travel, to get a little apparatus, called a mineralogical pocket book; it contains a common goniometer, an electrometer, a polar magnet, a blowpipe, a pair of forceps and leaf platina, and small bottles filled with fluxes and acids.*

Mary. What is the use of the acids?

Mrs. L. They have very different effects on different substances; some minerals when reduced to powder and mixed with an acid, in the course of a few hours become a perfect jelly: the native carbonates, when touched with acid, effervesce, some more vigorously than others.

Frances. Any mineral then, that will effervesce with an acid, is a carbonate?

Mrs. L. Yes; but you must remember that when there is some foreign matter combined with the carbonate, the effervescence will be but slow; and you will sometimes find it necessary to use a magnifying glass, and, occasionally, a little water is to be added;—the acid is sometimes too strong to produce the proper effect. If you still suspect that a disengagement of carbonic acid ought to take place, you may pulverize a little, and put it in a proportionate quantity of acid.

Mary. But I do not understand why a mineral should effervesce, because it is a carbonate.

Mrs. L. Effervescence is the disengagement of the carbonic acid, which, when free, is in the state of gas.

Frances. Is it not liquid then?

Mrs. L. No; it is an aëriform acid, heavier than common air or oxygen; in making a saline draught, you disengage the carbonic acid from the carbonate of potash or soda, by the addition of lemon juice, which contains citric acid; and it escapes in the form of bubbles;—the same thing takes place whenever a strong acid is brought in

* They are fitted up, and sold by Mr. Carey, Optician, Strand.

contact with a carbonate. Now I believe I have shown you as much of chemical mineralogy as you will in general find useful, in distinguishing one substance from another: the particular effects of the acids, alkalis and the blowpipe on many other minerals, I shall be able to show you when you see them.

CONVERSATION VI.

MARY.

WHAT beautiful specimens! If all minerals were as brilliant as these, how delighted I should be.

Mrs. L. If it is only the brilliancy of them which pleases you, I am afraid you will be very much disappointed when you see a drawer full of coal or clay; but, when you know more of the subject, you will find many specimens very interesting, which *now* you would, perhaps, hardly think worth looking at.

Frances. Are these amethysts, Mrs. L.?—I should suppose they were from their colour.

Mrs. L. They *are* amethysts; but not merely because they are purple—for this specimen is amethyst, though quite colourless. The name* was, at first, given to the purple variety of this mineral by the ancient Greeks (to whom it was known at a very early period,) on account of the power they imagined it to possess, of preventing intoxication;—and, for this reason, they often wore a ring, or some other ornament made of amethyst, as an amulet, that they might drink freely without fear.

Frances. What a strange idea! How do you think it could have arisen?

Mrs. L. It is said to have originated from the similarity of colour, in wine and the amethyst, (for none were called so formerly, but such as were purple,) and it is not more absurd than the prejudice that has induced people (even in England) to prescribe black or yellow medicine,

* From α not μεθυστος (methystos) drunk.

for the black or yellow jaundice; being thought more afficacious than medicine of any other colour.*

Mary. I cannot imagine how any one could believe such ridiculous notions, or how they could persuade others to believe them.

Frances. Before you go any farther, will you have the goodness to tell me why you place amethyst at the beginning of your arrangement, in preference to any other precious stone?

Mrs. L. I am glad to find that you like to have a reason for every thing. It is not because amethyst is a *precious stone*, that it takes precedence of other substances; but because it is a kind of *quartz* or rock crystal, which, for several reasons, seems entitled to the first place in the system, as I shall endeavour to show you.

Every system of mineralogy must be founded either on the chemical, or on the physical characters of minerals, or on a combination of both. The latter are the most convenient (if not the most useful,) and, therefore, are most generally adopted; but there is a great diversity of opinion on any important question which naturally suggest itself, where to begin? The French mineralogist, who have paid great attention to the crystallization† of minerals, considering it as their most important character, have, in general, placed at the beginning of their systems, those minerals which are composed of an earth and acid. The mineralogists of the German school appear to have selected a substance arbitrarily as the first in their arrangements, and to have formed their genera and families with much less regard to the chemical, than to the physical, characters; and even amongst *these*, have paid least attention to that which is, certainly, where it exists, the most unvarying. I mean crystalline form. But I think we should try to discover whether there is not any kind of *natural* order, which might, at least in *some degree*, be observed in the formation of a system.

* In the year 1644, Sir Kenelm Digby published a work "On the nature of Bodies," in which he treats at great length of sympathies.

† It is to the Abbé Haüy that we are indebted for the explanatory theory of the structure of crystals.

Mary. Certainly: if such an order exist, one would wish to adopt it.

Mrs. L. We know that the great masses which constitute the crust of the globe, are chiefly earths: these are by far more abundant than the metallic, alkaline, or inflammable substances; and are considered to be in general more ancient. You are surprised, and it is natural that you *should* be so; but it is an opinion almost universally received, by geologists, that the different parts of the globe are not of contemporaneous origin.

Frances. How is it possible to prove the truth of such a supposition? or why is it believed that the different parts of the world were not formed at the same time?

Mrs. L. An attentive examination of the geological structure of various countries has led to this conclusion; and it is a proof of the intimate connexion of mineralogy with geology: for you see that neither can be properly understood without the assistance of the other.

When you know something of mineralogy, I shall speak a little of the other branch; but at present, you must, if you please, take for granted what I have said on the subject, as you do the axioms of Euclid.

Mary. Indeed, Mrs. L. I shall be very glad when you think me able to understand the proofs of your doctrine: and, in the mean time, I will endeavour not to be sceptical.

Mrs. L. I have little doubt that you will be satisfied with the arguments in support of what is advanced. The knowledge of the different ages of minerals, shows that they have a claim to a succession in a somewhat natural order in our arrangements. I therefore begin with silica (in its purest form,) as it is the most ancient and most abundant of all mineral substances. Minerals are frequently divided into four classes; viz. the earthy, the saline, the metallic, and the inflammable* minerals. Many celebrated mineralogists, however, subdivide the first class into *earthy* and *acidiferous earthy minerals*, which renders

* Inflammable and combustible are not synonymous terms. All metals are combustible; that is, capable of uniting with oxygen; but they will not burn in atmospheric air, and are, therefore, not called inflammable.

the arrangement rather more chemical, and which I have adopted.

Frances. The term acidiferous, I suppose, is applied to those minerals of which some acid is a constituent.

Mrs. L. You are right: but observe, that the acidiferous minerals do not all form one class; for acids are found in combination with the earths, with the alkalies, and with the metals; and sometimes, one acid is combined with an earth and an alkali.

Mary. All the alkaline minerals, then, cannot be arranged together.

Mrs. L. No; but those in which an alkali is the principal constituent, are soluble in water, and these constitute the saline class.

The inflammable minerals are sulphur, the bituminous, carbonaceous, and resinous substances. But these two classes are much less extensive than the two others.

Frances. I should suppose the metallic class to be the most extensive of all, as the metals are so much more numerous than the earths, or alkalies.

Mrs. L. I am not surprised that you should think so; but you will find that the metallic minerals do not occupy above half as much space in my cabinet as is filled by the earthy ones.

Frances. That appears very strange. I cannot imagine why it should be so.

Mrs. L. Though the combinations of metals are very numerous, the different species present, in general, much less diversity of aspect than those which have an earthy basis. Each species has a more fixed character, and their chief variety is in their crystallization; for example, when you have once seen a specimen of sulphuret of lead or red oxyde of copper, you could scarcely mistake it for any thing else; though their crystalline form is very various: but this is not the case with *earthy* minerals; for the colouring matter of them is, in most cases, not an essential ingredient, and exists but in small quantity: yet this is sufficient to give a very different character to different specimens of the same substance.

There is another reason for the greater variety of appearance in earthy than in metallic minerals; the great repositories of all minerals are rocks and masses of stone, com-

posed of earths: very frequently they are found imbedded in rocks of a different nature and composition; and the character of many earthy minerals varies with the nature of the mass in which they are found.

Mary. And is not this the case with metallic ones?

Mrs. L. Not often; very few of the metals are found mineralized by the earths, which are silica, alumina, and yttria; but are united with oxygen, sulphur, or an acid, and are sometimes found in the state of alloys; and the characters of such compounds do not depend on the quality of the surrounding rock or bed.

Frances. I think I understand that—an earthy mineral cannot be imbedded in a mass of rock, without some mixture of the particles of both substances taking place.

Mrs. L. This is generally the case with those which do not crystallize; and those which do, are sometimes, though rarely, affected by the nature of their repository.

Each class of minerals is divided into *genera*, containing one or more *families*, and these are subdivided into species and varieties.

Mary. But if you arrange the minerals in *genera*, I do not understand what you mean by *families*. I should have thought they were different names for the same thing.

Mrs. L. The word *genus* means, literally, a kind; and the first division of the earthy class would naturally be into the principal *kinds* of earthy substances. We, therefore, have the siliceous, the aluminous, and the calcareous genus, with some others of less importance. The siliceous genus comprehends all stones of which silica is the principal constituent. All those which are principally composed of alumina are arranged in the aluminous genus, and so on. But many of these are *almost pure* silica, and are very similar in many of their external as well as chemical characters; as their specific gravity, there hardness, and their texture: these are all considered as belonging to one *family*. Other families consist of minerals, of which silica forms rather more than one half, but where some other earth is an essential constituent, and which have some external characters in common with each other, as the felspar family. But you will understand this better when you have seen some minerals. For

the present, I will just give you what is called a *tubular view* of my arrangement of the first class.

EARTHY CLASS.

ORDER I. Earthy minerals.

1st GENUS. (*Siliceous.*)

FAMILIES. Flint—Garnet—Idocrase—Schorl—Epidote—Pitchstone—Zeolite—Lazulite—Felspar—Mica—Slate—Clay—Lithomarge—Hornblende—Augite.

2d GENUS. (*Magnesian.*)

FAMILIES. Magnesite—Talc—Chrysolite.

3d GENUS. (*Aluminous.*)

FAMILIES. Ruby—Nepheline—Topaz—Cyanite.

4th GENUS. (*Zircon.*)

FAMILY. Zircon.

5th GENUS. (*Glucine.*)

FAMILY. Emerald.

ORDER II. Acidiferous Earthy Minerals.

1st GENUS. (*Calcareous.*)

FAMILIES. Carbonates—Phosphates—Fluates—Sulphates—Silicates—Borosilicates—Arseniates—Tungstates.

2d GENUS. (*Aluminous.*)

FAMILIES. Sulphates—Phosphates—Fluates—Mellates.

3d GENUS. (*Magnesian.*)

FAMILIES. Carbonates—Sulphates—Borates.

4th GENUS. (*Barytic.*)

FAMILIES. Carbonate—Sulphate.

5th GENUS. (*Strontian.*)

FAMILIES. Carbonate—Sulphate.

Frances. I see there is no particular family for the precious stones.

Mrs. L. The idea that all precious stones are composed of the same elements, which was adopted by the early mineralogists, has been long discarded: they are now arranged according to their composition, which, in many,

is essentially different. Amethyst is merely a kind of quartz.

Mary. But, Mrs. L., you said that all pure earths were white; what is it that gives this such a beautiful purple tint?

Mrs. L. A very minute portion of the oxyde of iron and manganese. In some of the paler specimens, you may see little tufts of fibres, (which are crystals of oxyde of iron and manganese,) and just around them the colour is deeper than in the other parts.

Mary. O, how beautiful!—they are like little hair pencils.

Frances. This shows very plainly that the colour is not *necessary* to amethyst; but what are its essential characters?

Mrs. L. Amethyst, as well as all the other species of the quartz family, possesses a certain degree of hardness; you cannot scratch them with a knife, or with glass.

Mary. It is very easy, then, to discover a real amethyst from a false one, by trying if it will scratch glass.

Mrs. L. A more certain method is to try if it will scratch quartz; for most of the compositions, made in imitation of precious stones, are sufficiently hard to scratch flint glass. The specific gravity of the different varieties of quartz is, in general, about 2.6; they are all infusible before the blowpipe, without the addition of some other substance, and are rather brittle. The distinctive character of amethyst is that peculiar coarse fibrous fracture, or columnar structure, which is more conspicuous in this white specimen than in the others.

Frances. But is not this fracture radiated?

Mrs. L. In this instance it is—but that is not always the case with amethyst.

Mary. Do lend me a magnifying-glass, Mrs. L., I think the outside of this piece is crystallized.

Mrs. L. Most minerals which have a fibrous, or radiated structure, consist of an aggregation of crystals—this arrangement is also called fasciculated. I do not think you will be able to make out the crystals of the specimen in your hand, because the ends are small and imperfect, but they are exactly similar to those of rock-crystal, which are large and more convenient to study. (Pl. III. figs. 35, 36.)

Frances. Is all this specimen amethyst, Mrs. L.? It appears to me as if the points of the crystals were covered by some other substance like agate.

Mrs. L. It is calcedony, one of the principal components of most agates. It is not uncommon to meet with fibrous and crystallized amethyst in the centre of agate balls; but in these cases, the points of the crystals are not imbedded in the agate, but appear to be growing on it, so that only the pyramids are seen lining the cavity. That crystallized specimen, which you have just taken up, was brought from Siberia—and those fragments are from the Brazils.

Frances. These fragments puzzle me a little, for I see no marks of a fibrous structure.

Mrs. L. No; the fracture is conchoidal; and so it is in the crystallized part of *all* amethysts—but the fibrous varieties split so readily into columnar fragments, that you do not, at first, perceive the cross-fracture, as it is called.*

Mary. I see it plainly, now you mention it.

Mrs L. It is probable that these Brazilian amethysts are fragments of some large mass, partly fibrous, partly crystallized.—What would you say of the lustre of the fracture?

Mary. I should think the lustre was vitreous—but I do not know what degree of brilliancy it has.

Mrs. L. The most brilliant varieties may be termed shining, the least so, glistening; but the *external lustre* varies from splendid, to nearly dull.

Frances. I think this is *quite* dull—how oddly the crystals are aggregated

Mrs. L. Yes, that is not a common occurrence; when the large crystals appear so surrounded by smaller ones closely attached to them, the groupes are said to be bud-shaped. This specimen is from Hungary—those of which the summits of the crystals are white, and the bases coloured, are from Mexico. I believe there is nothing remarkable in the others: it occurs of every shade intermediate between dark plum-blue and white: sometimes the points

* The fracture of amethyst may be said to be fibrous in the large; conchoidal, in the small.

of the crystals are purple, and the other part of a greenish tint: some have a milky appearance, and many of those, in which the purple colour approaches to brown, are nearly opake.

Mary. You have, indeed, a very fine series of colours.

Frances. Do amethysts come from any other places than those you have mentioned?

Mrs. L. A great many: they are found in considerable quantity in many parts of Germany, Saxony, and Bohemia—in Sweden, Switzerland, France, and Spain; in Iceland and the Faroe Isles—and I have a specimen from Mayo in Ireland. But most of those which are used by jewellers, are brought from Cambay in India, Brazil, and Siberia—it is also found in Persia. The largest specimen of amethyst I ever heard of was sold at the Custom House some months ago, it weighed 130 pounds, and the crystals varied from one to four or five inches in length. It is now in the collection of the Royal Institution.

Mary. I recollect having heard of it, but I believe it was not of a good colour.

Mrs. L. No, it could not have been used to cut up.

Frances. And in what sort of rock is amethyst found?

Mrs. L. Chiefly in the veins of mountains with metallic ores, or with agate, in the cavities of greenstone and porphyry rocks. All the amethyst and quartz of Bristol is acompanied by ironstone, and there is some specular iron on the specimen from Cornwall.

Mary. Well, I hope when I go into Cornwall that I shall find some; I assure you I shall not return without seeing the subterranean wonders of the county.

Mrs. L. It is not *impossible* that you should meet with them, but I fear you will be disappointed, for they are not plentiful there; but you may get fine specimens of common quartz, and some of rock crystal.

Frances. Are these rock crystals from Cornwall?

Mrs. L. No, I do not think that crystals of that size have ever been found in Great Britain; that specimen is from Madagascar, but most of the others from Dauphiné. The groupe of rock crystal on the cabinet, of which the crystals are nearly a foot in length, is from Madagascar; and there are some much larger in the British Museum.

Mary. How very transparent these are; and beautiful-

ly crystallized. Is this the primitive crystal? (Fig. 36, Pl. III.)

Mrs. L. No, that is one of the most common forms of rock crystal, but not the most simple—the primitive is a slightly obtuse rhomb.* (Fig. 32, Pl. III.)

Frances. Pray show me some, for I do not see any here.

Mrs. L. They are very small, but you may see them distincty on this specimen.

Frances. Yes, I do; they are brownish.

Mary. But, Mrs. L., are these little things rock crystals?

Mrs. L. Rock crystal is merely a name used to designate the transparent prismatic crystals of quartz, such as those from Dauphiné, or the yellow variety from Brazil —they are all quartz, but when the prism is very short as in these, (fig. 35.) or it is not transparent, the mineral is called common quartz. The primitive crystals are from Bristol, and these (fig. 33.) where you see the lower angles are replaced by small planes, which, if extended, so as to meet, would form a triangular dodecahedron.

Frances. Would it be similar to any of the dodecahedrons of carbonate of lime?

Mrs. L. It is not like the metastatic, or any other produced by that kind of decrement: but there is a crystallization of carbonate of lime, which is very rare, that resembles it. The faces of the common dodecahedron of quartz, are isosceles triangles, and the base of the pyramids is a regular hexagon, which you know is not the case with the dodecahedrons of carbonate of lime, in general. Quartz very rarely assumes any dodecahedral form except this, (fig. 34.) but I have seen *one* like the metastatic of carbonate of lime, and most probably produced by a similar decrement.† Here is a very perfect dodecahedron from Spain.

Mary. And where did you find these little crystals?

Mrs. L. In Derbyshire, near Bakewell. I have some also from Scotland.

Mary. I think when you were speaking of crystalliza-

* The angles of incidence of the planes are 94° 15'. & 88°. 45'.

† In the possession of Henry Heuland, Esq.

tion, you said that it was extremely difficult to find the cleavage of quartz; how could the primitive be obtained from one of these crystals?

Mrs. L. I believe the best method is, to heat the crystal gradually to rather a high degree, and then plunge it into cold water: if it does not split immediately, you will perceive a number of cracks within it, which are parallel to the plains of the rhombic nucleus.

Frances. Then I suppose a blow with a hammer would divide it into rhombs.

Mrs. L. A hammer will *sometimes* answer the purpose, but you will find different kinds of pincers useful in cleaving crystals.—Sugar nippers are good things; and the little pincers which are used for cutting wire.

Frances. I do not think I shall ever be tempted to destroy crystals for the sake of discovering the cleavage.

Mrs. L. It is probable that it will never be necessary for you to do so—as the primitive form of most minerals is known. The primitive rhomb, and the dodecahedron of quartz, occur much less frequently than the prismatic crystals. (Figs. 36, 37, 38.)

Mary. I cannot understand this crystal, Mrs. L.: it has the same number of faces as the one you have just shown me; but it appears very irregular.

Mrs. L. That irregularity arises from the different size of the planes of the pyramid; three of them have been extended at the expense of the others. (fig. 37,) and the specimens from Dauphiné are characterized by the great size of *one* face.

Frances. Here is one of that kind—it appears at first sight, as if these were no other plane on the summit.

Mary. But you may see them very easily with a glass, (fig. 38.) two of them are very narrow,—the one opposite to the large plane, is rather wider in proportion to its length; and the two others are triangles.

Frances. No, Mary, they are not *both* triangles; one of them is a trapezium.

Mrs. L. I am glad you can easily discover these little planes, because you will derive amusement as well as instruction from looking over my crystals. But as there is great variety, I shall, at present, only point out to you the most remarkable.—Here is one, where the part which you

would at first think to be a prim, is part of a very acute pyramid. (Fig. 40.)

Mary. Really if you had not shown it to me, I believe I should have overlooked it.

Frances. Is not this one of the same kind? (Fig. 41.)

Mrs. L. Yes: but in this crystal the long pyramid has *nine* sides,—for three alternate edges are truncated.

Mary. Is that a rare crystal?

Mrs. L. Yes, rather so.—On this crystal you will see a modification which, if complete, would produce an equiaxe rhomb,—you know where to look for planes formed by such a decrement. (Fig. 42.)

Mary. Yes,—they are the very narrow planes on the upper edges of the rhomb.

Mrs. L. That is only the commencement of the decrement.

Frances. Is not that a crystal of Cairngorm?

Mrs L. That is a common name for tha quartz of a yellow or brown colour; because they were first found at the mountain of Cairngorm in Aberdeenshire, but that specimen is from Switzerland. The brown ones are sometimes called smoky quartz. The specimens are arranged so as to form what is called a *suite of colours;* that is, to show the different tints of each colour, passing into others. I have placed after the white and colourless quartz, those which are gray and greenish, then the yellowish white, the different shades of yellow, the light brown, and the dark brown varieties, which pass into red, of which there are several kinds.

Mary. Is there no pink or crimson quartz, Mrs. L.?

Mrs. L. Quartz has been found of a beautiful pink: but it never crystallizes, and is considered as a distinct subspecies,—Crimson quartz has not yet been discovered. Crimson and blue are the two colours which occur less frequently than the others.—Green and red, I mean the kind of red such as you see here are the most common.—The darkest and brightest specimens very much resemble venetian red, for the colouring matter of both, is oxyde of iron

Mary. All the yellow quartz is very transparent, and most of the brown crystals, even some that are dark; but

there is scarcely any red that is not nearly opake.—What is the reason of this?

Mrs. L. Their opacity arises from the quantity of oxyde of iron which is unequally dispersed through them. There are little crystals of this red quartz, found near Compostella in Spain, which are called Hyacinths of Compostella. I have fixed some on little pedestals, for they are beautifully crystallized, though not above a quarter of an inch in length. You see they are quite opake, and both ends crystallized. Most of the red quartz is from Bristol.

Frances. Have you any quartz containing drops of water? I recollect some specimens of it in the Museum.

Mrs. L. Yes, here is a crystal which contains a large drop; it is not very transparent, but if you move it gently between your eye and the light, you may see it.

Frances. But how oddly it moves.

Mrs. L. The water is contained in a space larger than itself, and it is a bubble of air which you see moving in the water.

Mary. Is not the mossy looking substance in this crystal, chlorite?

Mrs. L Yes,—how did you know it?

Mary. Because it is so much like a specimen of quartz enclosing chlorite, at the Museum. Is chlorite always dark green like this?

Mrs. L. No, it is sometimes brown; and in this crystal white, and, in parts, of a light gray colour. Epidote, actinolite, hornblende, specular iron ore, and some other minerals, are also occasionally found in quartz.*

Mary. Quartz, I see, is not always crystallized.

Mrs. L. No, but it often assumes remarkable external forms, as well as being found massive and amorphous.

Frances. What is the meaning of *amorphous?*

Mrs. L. It signifies without form; that is, without any regular form or crystallization. Sometimes it is pseudomorphous, which means having a false form; this is of two kinds: quartz has covered or invested other substances, which have since been decomposed, leaving hollows and impressions in the quartz in the form of the crystal on

* In the British Museum there is a piece of quartz about an inch and a quarter in length, which contains a crystal of cyanite.

which it has been deposited, or it occurs in the form of other crystallized minerals. Here is a specimen, of which the crystals are cubic, and have been produced by a deposition in a mould left by fluor.

Mary. But what is become of the fluor?

Mrs. L. It has been gradually decomposed and removed by the agency of some other mineral substance near it. Here is a pseudomorphous crystal, in the form of the metatastic dodecahedron of carbonate of lime, from Bristol. Swimming quartz is a variety of the other kind of pseudomorphic formation.

Frances. Will it really swim on water?

Mrs. L. It will float as long as the little cavities remain filled with air; for the quartz is so very thin, and the interstices so numerous, that the specific gravity of the mass is less than that of water; but the specific gravity of quartz being about 2.6., as soon as the water has displaced the air, it will sink. That brown specimen is from the Cape of Good Hope; the white one from Cornwall. It is also called cellular, spongy, or cavernous quartz.

Frances. How very delicate the white one is!

Mrs. L. I must request you not to touch that specimen; it is so very brittle, that the slightest pressure on the edges would crush it.

This mineral, which is found at St. Ouen, near Paris, is another variety of cellular quartz, called floatstone.

Mary. It appears, at first, more compact than the other specimens we have seen.

Mrs. L. That is only because the interstices are smaller, and far more numerous. The centre of some specimens is solid fruit, while the outside is quite porous; it is not, however, very pure silica, as it contains a portion of water, and sometimes a small quantity of carbonate of lime.* These are specimens of *massive* common quartz; the fracture approaches to oily. This, which is nearly opake is fat quartz.

* CONSTITUENT PARTS.

Silica	98.0	94.0	91.00
Water	——	5 0	6.00
Carbonate of lime	2.0	——	2.00
Oxyde of iron with alumina	——	0.5	0.25
Vauquelin.	100.0	99.5 *Bucholz.*	99.25

Mary. That is just like the pebbles, which I told you I rubbed together, to see the light produced by them.

Mrs. L. Any two pieces of quartz would have produced the same effect; and it is curious that they will even do so under water, for it is by no means the same as the light produced by striking a flint and steel together.

Most fat quartz, when rubbed, emits a peculiar and very unpleasant smell; this is not always the case, but some has been discovered near Nantes, in France, which, on being broken, gives out an odour resembling sulphuretted hydrogen,* so disagreeable, that Steffens (a celebrated mineralogist) has called it stink quartz.

Mary. What is that owing to?

Mrs. L. It is supposed that the quartz contains bitumen, which is the cause of a similar smell in black lime stone.

Sandstone is a granular kind of quartz, of which there are many varieties. Sometimes the particles are so small, that it is almost compact; these kinds are very hard. Some sandstones are coarse granular; in others, the parts have so little cohesion, that they are friable, and may be easily crumbled. The most remarkable variety is a flexible kind, found in Brazil, and at the mountain of St. Gothard in Switzerland. I have a fine specimen from Brazil, above 18 inches long; you may lift up either end of it without taking it out of the drawer.

Mary. How very curious it bends like a piece of thick leather, but more easily.

Frances. You may lift either end of it two inches from the bottom of the drawer; but it is cut into this form is it not?

Mrs. L. Yes, it is merely a narrow strip; you would scarcely perceive the flexibility of this in a large or thick mass. But here is a piece from the Yellow River in China; which, when it has been immersed in water for some time, is not only flexible, but elastic. If you press your finger on it forcibly, it will leave a slight impression; but, on being left, it will regain its original position in a short time.

Frances. I never saw any thing so extraordinary.

* The mineral waters of Harrowgate owe their unpleasant smell to sulphuretted Hydrogen.

Mrs. L. You may squeeze it like a piece of beef; indeed the sailors who discovered it, called it petrified round of beef.

I believe this kind has been found near Whitby, in Yorkshire. These sandstones are nearly white, but it is frequently stained with yellow, orange, red, brown, or purple. Sometimes it is irregularly striped with these colours.

Mary. And what is the colouring matter?

Mrs. L. Iron, which in different states, communicates the colour to most earthy minerals. In the red sandstone, it is in the state of an oxyde. The yellow colour is owing to a mixture of carbonate with the oxide. Sand is very often coloured in the same manner.

Frances. But it is sometimes quite white, is it not?

Mrs. L. Very fine sand, almost perfectly white, is found at alum Bay in the Isle of Wight, on the coast of Norfolk, and at Reigate in Surrey. This kind is used for making glass. At Alum Bay it is found in the sand cliffs, which are really beautiful, from the great variety and brilliancy of their colours; they are yellow, red, and purple, of various shades, arranged in stripes. The next specimen is rose quartz.

Mary. What a very delicate pink!

Mrs. L. That is caused by a very minute portion of the carbonate of manganese. This subspecies has never been found crystallized. It occurs in large masses in the granite of Bohemia and Bavaria, in the Harzberg Forest, and in some parts of North America.

Frances. I should think it would make beautiful ornaments; is it ever used for that purpose?

Mrs. L. Yes: when it is of a deep rose red, it is cut and polished. The paler varieties, when cut, have a milky appearance, and are sometimes called milk quartz.

Mary. I think it is not always easy to distinguish milk quartz from massive common quartz. Some of these specimens are very much alike.

Mrs. L. They pass into each other; which is very often the case with two or more subspecies.

Frances. Then it is not necessary that every mineral in a collection should belong to a particular species or subspecies.

Mrs. L. Certainly not. It is useful to have others which are intermediate, to show the connexion between them; besides, you will recollect that all division into families, species, and subspecies, is artificial. It is often difficult, if not impossible, to draw the line of distinction between two subspecies.

Mary. Here is a specimen, however, which appears to have no connexion with the preceding ones.

Mrs. L. That is avanturine.

Frances. Are those beautiful shining particles, gold?

Mrs. L. No; they are scales of mica; a mineral better known by the name of Muscovy talc. The rich reddish brown colour of the quartz in which they are disseminated, makes them appear very brilliant.

Mary. Yes; but it is very much improved by polishing.

Frances. The mica in this red specimen is in extremely small scales, so that they appear like bright points, and it is almost as beautiful in its natural state as polished.

Mrs. L. That is a different kind of avanturine; the bright particles are not mica, but merely the effect of numerous very small fissures in the quartz, which reflect the light from the internal surfaces; just as you see where a pane of glass has been cracked, by the reflection from the surface of the fracture. This variety, which is the most valuable, is brought from Spain. It occurs of several different colours: yellowish, greenish, grayish, and reddish-white; sometimes, flesh-red and pale crimson, and it has been found at Glen Fernat and Fort William, in Scotland. The next mineral you are already acquainted with in a *cut* state; it is cat's eye.

Frances. I have seen a great many cat's eyes polished, but this has a very different appearance.

Mary. It looks much better in the rough state; for I think, when polished, it hardly deserves to be called a precious stone.

Mrs. L. It is, nevertheless, much admired in England, but is still more highly prized by the East Indians, who consider it as an amulet against bad eyes, and give an immense price for the large ones.

Frances. That is something like the prejudice respecting amethysts.

Mrs. L. There is scarcely any country where superstition has not attached miraculous properties to particular stones and plants. The Indians attribute certain virtues to most of the precious stones; but I believe they consider the cat's eye superior to the others. For this reason, very few of the large ones are brought to England.

Mary. Most of these are larger than any I have seen before; here is one above two inches long.

Frances. Does it ever crystallize?

Mrs L. No: it has never been found otherwise than in rolled pieces.

Mary. What is the cause of the opalescence?

Mrs. L. The fibrous texture of the mineral. It is not like the fibrous structure of amethyst, for in cat's eye the fibres are so very fine, that it approaches to compact, and the fracture is small and imperfect conchoidel. Fibrous gypsum and satin spar exhibit nearly the same appearance, when polished. The opalescence has been supposed by some, to proceed from a mixture of amianth with the quartz. Here is a polished piece of quartz, containing gray amianth, which was found in the Hartz; but amianth contains magnesia, and none has been discovered in cat's eye.

Mary. But I suppose this is not pure silica, or it would be transparent like rock crystal.

Mrs. L. No; it consists of 95 parts of silica.

95	parts of silica.
1.75	alumina.
1.50	lime
0.25	oxyde of iron.

Frances. In what part of India is it found?

Mrs. L. In the islands of Ceylon and Sumatra; in Persia, Arabia, and on the coast of Malabar. It varies in transparency, but always has the same silky lustre and opalescence.

Mary. Is this dark green stone a cat's eye too? It appears slightly opalescent.

Mrs. L. No: that is a small piece of prase, cut in the form usually given to cat's eye.

Frances. Is that a kind of quartz?

Mrs. L. It is quartz containing actinolite, so intimately

mixed with it, that at first it has the appearance of a simple mineral. I have several specimens which show the two substances differently intermixed. In this one, the quartz is transparent, and you may see the thin crystals of actinolite within it.

Frances. Yes: they are very distinct; they are a good deal like the crystals of iron in the Bristol quartz.

Mrs. L. Actinolite is generally of a dark green, but these crystals are particularly dark.

Mary. It is paler in some of these specimens where the actinolite is radiated.

Mrs. L. When the mixture of the two substances is very complete, prase is of a leek green colour. The fracture is not exactly the same as that of quartz, but approaches to splintery. The transparence depends on the quantity of actinolite which it contains; but it is seldom more than translucent on the edges. There are very few minerals for which you will be likely to mistake it.

Mary. Then it does not pass into any thing?

Mrs. L. Nothing, except rock crystal or quartz; it is not an abundant mineral. You should remember, among the other characters, that the fragments of prase, and all the other subspecies of quartz, (except sandstone) are sharp edged; they are least so in cat's eye. And all these substances will give sparks with steel.

Mary. Then, could you use them instead of flint?

Mrs. L. Yes, but they would not answer the purpose quite as well, because they are more brittle than flint. The second subspecies is ferruginous quartz, or iron flint.*

Frances. Is this red specimen, iron flint? It is very much like jasper.

Mrs. L Being polished, you cannot easily perceive the difference, but if you compare the fracture of the two substances, you will see that the fracture of jasper is dull, but there is a good deal of lustre in that of iron flint.

Mary. Yes; it is interspersed with very minute shining particles.

* Iron flint is a literal translation of the German Eisenkeisel.

Mrs. L. There is less of that appearance in some of the brown and yellow varieties, which are more compact.

Frances. Here are several shades of brown, but they all approach to yellow. Is not this fracture conchoidal.

Mrs. L. Yes; but in some specimens it passes into uneven and fine granular, particularly in the red ones; but you have only looked at the massive varieties; here are some, crystallized.

Mary. What a confusion of little crystals! they appear to be cemented together by the same substance.

Mrs. L. That yellow specimen is very fine; the crystals are so large and distinct.

Frances. Yes, I see the crystals are, in general, not much larger than pins heads,—but some of these are above a quarter of an inch long.

Mrs. L. In this specimen you may see a beautiful gradation from pure quartz to iron ochre. Some of the crystals are quite transparent and colourless;—others contain small quantities of the ochre in the centre of them, and where there is very little silica, the fracture is earthy.

Mary. Will this strike fire with steel?

Mrs. L. Yes, except in the part where the ochre predominates. The specific gravity varies from 2.6 to 2.8; the quantity of iron is different in different specimens, which is most probably the cause of this variation:—

CONSTITUENT PARTS.

Silia	93.5	92.00	76.83
Alumina	—	—	0.25
Oxyde of Iron	5 0	5.70	21.66
Oxyde of Manganese	—	1.00	—
Volatile mátter	1.0	1.00	1.00

Frances. What is this glassy-looking mineral?

Mrs. L. That is hyalite: the word is derived from 'υαλως (hyalos,) which means glassy,—it is good deal like quartz, but contains 6⅓ per cent. of water, and it is never crystallized.

Mary. How very smooth and bright the external surface is.

Frances. It looks like a quantity of gum arabic half dissolved. I cannot see any fracture; it is spread so thinly over this brown rock, and in little round masses.

Mrs. L. Here is a specimen on which the hyalite is as large as peas—the fracture of it is small conchoidal, and it is a very brittle substance.

Mary. How do you distinguish it from quartz?

Mrs. L. Pure quartz never occurs disseminated on another mineral, unless crystallized. The specific gravity of hyalite does not exceed 2.46, which is owing to the quantity of water it contains.

Frances. What kind of rock is this? it looks to me like lava.

Mrs. L. It is called trapp.

Mary. What a strange name!

Mrs. L. It is a Swedish word, meaning a step or stair, which has been adopted by most mineralogists, to signify a rock, which has a form somewhat resembling steps,—it is often vesicular, as in this instance, and sometimes other substances occur in the cavities. Some trapp rocks contain zeolite; others agate, opal, or carbonate of lime, and many other minerals. In several of its characters, hyalite resembles opal more than quartz, and it is therefore placed next to it. There are several kinds of opal; the first is, that so much valued in jewellery—precious opal.

Mary. I think it is the most beautiful mineral in the world;—look at this exquisite green.

Frances. I cannot see your green, but this specimen shows brilliant flashes of crimson and pale purple.

Mrs. L. The colour of opal, independent of the reflected light, is generally milk or bluish white; but when held between the eye and the light, it appears of a pale muddy yellow. I think you will admire this specimen very much,—it is opal disseminated in small particles through gray porphyry.

Mary. I think it is even prettier than the pieces of pure opal.

Frances. Is opal brittle? it appears full of little cracks.

Mrs. L. Yes, it is very brittle;—one of the finest specimens in the world, which was for many years in the imperial cabinet at Vienna, was lost by being constantly exposed to the rays of the sun, (in order to show it to greater advantage,) which expanded the air contained in the little cracks, and it broke to pieces.

Frances. What a pity!

Mrs. L. The two next sub-species, common and semi-opal are entirely without the beautiful play of colours, which is characteristic of precious opal.

Frances. In this semi-opal?

Mrs. L. No, that is common opal,—it resembles precious opal, except in the want of opalescene—and it contains less water.

Mary. Does precious opal contain more water than hyalite?

Mrs. L. Yes, it consists of 90 parts of silica, and 10 of water, but some varieties of common opal are without water.

ANALYSIS.

Common opal of Kosemtüz.*			Common opal of Telkobanya.*
Silica	- -	98.75	- - - 93.50
Alumina	- -	0.10	- - - ——
Oxide of Iron	-	0.10	- - - 1.00
Water	- -	——	- - - 5.0

In the fracture of semi-opal, the lustre is generally waxy, and it is often dark gray and brown, and more rarely it occurs of a dull greenish yellow and olive green. None of the colours are bright, so that I do not expect you to admire these much at present; but to a mineralogist, this is a very interesting series, as it shows the connexions between the three subspecies,—the common and semi-opal pass into each other.

Frances. Is this red specimen, common opal?

Mrs. L. No, that is a much scarcer mineral, called fire or sun opal—if you look *through* it, you will see that it is very transparent; but looking down on it, you will perceive ap eculiar irridescence—you must let the sun shine on it, for it requires a bright light.

Frances. I see a green colour in the interior of it.

Mary. And a bright red,—not like the general colour of the mineral, but quite a crimson.

Mrs. L. These are the only two irridescent colours of fire opal: it is mostly of a hyacinth red colour, but a sky blue variety is said to have been discovered lately.

* Klaproth.

Frances. You said it was a scarce mineral, where is it found?

Mrs. L. Excepting a specimen that was raised many years ago from High Rosewarne mine in Cornwall, we are only acquainted with one locality of fire opal which is Zimapan in Mexico.

Mary. Are any of the other varieties found in England?

Mrs. L. Yes, several specimens of common opal have been brought from Cornwall.

Frances. What are these little bits of white mineral, quite dull and opake,—surely not opal?

Mrs. L. It is a kind of opal called hydrophane, from its property of becoming semi-transparent by immersion in water.

Mary. I should like to see that experiment.

Mrs. L. Here is a glass of water,—you will see the effect produced, in a few minutes.

Frances. What a stream of little air bubbles rose from it when you put it in.

Mrs. L. It is very porous, and therefore the water is quickly absorbed, and displaces the air—for the same rea-it adheres slightly to the tongue:—try it.

Francis. I confess I do not like the sensation.

Mrs. L. You see the pieces in the glass are rapidly losing their opacity.

Mary. One of them reflects beautiful colours, like those in precious opal.

Mrs. L. Hydrophane is probably common or precious opal, deprived of part of the water it contains, for it is very similar to those parts which have lost their transparency by exposure to the air.

Mary. What is the specific gravity of opal?

Mrs. L. The specific gravity of all these subspecies, varies from 2.00 to 2.18. The variety called mother-of-pearl opal, or cachalong, is rather heavier, the specific gravity is not lower than 2.20.

Frances. How very delicate that bluish white colour is!

Mary. Some parts of it are yellowish white and opake; is it all cacholong?

Mrs. L. Yes, that opacity has been caused by exposure to the atmosphere;—this kind has not been analysed, but it appears probable that it is an intimate mixture of calce-

dony and zeolite: it is frequently striped or branded, as in this specimen, one of the bands being much more transparent than the other. The translucent part is pure calcedony, the rest is cacholong. Here is a still better example; one half is semi-transparent calcedony, the other is fibrous zeolite, and quite opake.

Mary. The colour, then, is owing to the calcedony, and the opacity, to the zeolite?

Mrs. L. Yes.

Frances. Is cacholong found in England?

Mrs. L I believe not; but it occurs in Scotland, Iceland, the Faroe Isles, and in many of the rocks in which calcedony and opal are found.

Mary. Is not this a specimen of petrified wood?

Mrs. L. Yes, it is wood converted by the process of petrifaction into a kind of opal; it always occurs in the form of stems and branches of trees, though none of the original substance remains.

Frances. But in this piece you may see the part that has once been bark; and how very distinctly the grain of the wood is preserved.

Mrs. L. In the gray specimen it is shown by the dark concentric rings:—but you can scarcely perceive, at first, that this yellowish one is wood opal.

Frances. The lustre of wood opal seems to me very different from that of the other subspecies, it appears as if it were gummed.

Mrs. L. It does; but there is no single word in mineralogy which expresses that appearance.

Mary. Here are some curious looking minerals.

Mrs. L. That is menilite:—there are two kinds of it, gray and brown.

Frances. Is it not a kind of semi-opal?

Mrs. L. No; it is now considered as a distinct species, though it has been, at different times, arranged with opal, jasper, and pitch stone. It always occurs in these small tuberose masses which appear connected together, as if it had been poured into the adhesive slate (in which it is imbedded,) in a liquid state.

Mary. Is this the *gray* menilite?

Mrs. L. No; that is the brown:—the external surface of both kinds is blueish gray, but the fracture of this is

greenish brown—in the other kind it is light gray. The form of the concretions, too, is different—the masses of gray menilite appear compressed, and the surface is smoother than in the brown variety.

Frances. Is not the fracture foliated?

Mrs. L. The term foliated is only applied to those minerals which have a crystalline structure—this is slaty:—it does not, however, *always* afford a slaty fracture; for it is sufficiently compact to be broken in other directions and in this case the fracture is conchoidal.

The gray menilite is found in an argillaceous marl at Argenteuil, a little to the south of Paris, and at St. Ouen, not far distant:—but the brown variety occurs only at Menilmontant, to the north of Paris. It differs from all the species with which it has been arranged, in the peculiarity of its form and its localities.

The sixth species is called siliceous sinter.

Frances. What is the meaning of sinter?

Mrs. L. It is a German word, which is applied to any mineral having a stalactitic form:—you have seen stalactites in the caves of Derbyshire.

Frances. Yes; they hang like icicles from the roofs.

Mrs. L. Those are formed by deposition from water containing carbonate of lime.—Siliceous sinter is produced by the Geysers and hot springs of Iceland, which contain a considerable quantity of silica.

Mary. Is quartz, then, soluble in hot water?

Mrs. L. Not at the surface of the earth; but the water of the Geysers is considerably hotter* than boiling water, and contains a small quantity of alkali. This substance is not always stalactitic; but though it assumes various forms, it still retains the name of sinter.

Frances. I think this is what you term botryoidal; it appears bubbled, like the hyalite.

Mrs. L. Yes, that is one of its most common forms: it occurs also coralloidal, and resembling moss: the large masses of this kind have exactly the appearance of cauliflowers growing around the Geysers. The porous va-

* The water of these springs boil at the surface of the earth; but the temperature must be considerably higher than 212° in the interior of the earth, where it is subjected to compression.

rieties generally contain vegetable substances, for they are found *beyond* the basins from which the Geysers rise. Here is a specimen full of little bits of straw, and small stems, which seem to have been entangled in it.

Mary. This is similar to the effect produced by the petrifying springs at Matlock.

Mrs. L. The term petrifying is applied incorrectly to these springs; they only *incrust* the substances thrown into them.

The sinters formed *within* the edge of the basins are more compact, and are reddish white, light red, and various shades of gray.

Mary. That light red one is striped like agate.

Mrs. L. When it has the appearance of having been formed by several successive depositions, arranged in layers, it is said to consist of lamellar concretions. One variety of silecious sinter is opaline, and sometimes marked with black and blue spots.

Frances. The fracture is very shining, but I do not know how to describe the kind of form.

Mrs. L. It is intermediate between fibrous and uneven.

Mary. Here is a prettier specimen than any of those you have shown us: the outside is pearly.

Mrs. L. That is pearly siliceous sinter: it differs a little from the other subspecies in composition, and is not produced by deposition from the hot springs. The form is generally stalactitic, or appears to be an agglomeration of small globular masses.

Frances. Are these substances as hard as quartz.

Mrs. L. Not quite—but they will scratch glass. The pearl sinter was first discovered at the foot of the hill of Santa Fiora, in the island of Ischia, whence it has been called fiorite.

Frances. I suppose the specific gravity of these is rather low?

Mrs. L. Yes; it varies from 1.80 to 1.91.

Mary. I am glad to see some flints: I have been expecting them for some time.

Mrs. L. It is a substance so well known, that it will not be necessary for me to say much about it. I have a good many specimens to show the peculiar forms and different colours of which it occurs.

Frances. I see here are some containing quartz crystals. I recollect finding some once, in breaking flint pebbles.

Mrs. L. It is not at all uncommon to find them lining the cavities of flint.

Mary. What are the whitish substances in some of these specimens?

Mrs. L. They are petrifactions of alcyonia, fungi or sponges, which do not in general fill the cavities in which they are situated. The outside is generally rough, and nearly white; but if you break them, you will find they are internally of the same colour as the surrounding mass; petrified shells, in the state of flint, are often met with. Here is a piece in which a small echinus is imbedded.

Frances. How very perfect it is.

Mrs. L. When flint is of only one colour, it is most commonly gray or brownish yellow; but variegated flints often present brighter colours, arranged in spots and stripes, either straight or curved.

The fracture of flint is always perfect and large conchoidal, and the lustre feebly glimmering, sometimes dull in the more opake varieties.

Mary. What is the reason that these dark flints are chiefly white externally?

Mrs. L. In some, the white crust has been produced by exposure to the atmosphere, others are in their original state.

There are immense beds of flint in the chalk cliffs, on the south coast of England, in the form of irregular nodules, which often have a white crust; and gravel, which is very abundant, consists of flint pebbles of different sizes, rounded by attrition. The same kind of pebbles are frequently imbedded in a coarse sandstone, forming a mineral known by the name of pudding stone.

Frances. I have seen some of this before, cut and polished; the red pebbles are really very much like plums.

Mrs. L. A great deal of this conglomerate is found in Hertfordshire. Flint passes into calcedony and carnelian, which often line the cavities in botryoidal or tubercular forms. This is particularly the case in the flints of Dor-

setshire, and the western termination of the chalk stratum. Flint also passes into conchoidal hornstone, which you see is placed next to it. The name, hornstone, was first given to the variety which breaks with a splintery fracture, from its slight resemblance to horn: this kind is more like common quartz than flint. The most common colours of hornstone are reddish white, milk white, and very light gray, sometimes stained with dull yellow.

Frances. Some of the splintery hornstone is marked with small irregular dark spots.

Mrs. L. That is probably chlorite. Hornstone sometimes occurs in supposititious crystals, which most commonly have the form of carbonate of lime, or fluor; and it very frequently appears in the form of madrepores. It may be distinguished from flint by its inferior hardness and want of lustre.

Frances. Does the composition of it differ from that of flint.

Mrs. L. It is most likely that it does; but it has not yet been analyzed. Wood is often found petrified by hornstone; and is then called woodstone.

Mary. How beautifully some of these specimens are marked with scarlet and crimson.

Mrs. L. Those are from India. The woodstone of Warwickshire and Bedfordshire is mostly brown; that from the Isle of Portland is nearly white, and contains quartz crystals in the rifts. These are specimens of calcedony, and carnelian, which is considered as a subspecies of it.

Frances. What is the difference between them?

Mrs. L. If you examine them, you will see that the fracture of calcedony, though generally conchoidal, or even, approaches to splintery, and is quite dull; but in carnelian, the fracture is conchoidal, and faintly glistening, particularly in *red* carnelian.

Mary. Is not this pale blue crystallized substance calcedony?

Mrs. L. Yes; the crystals are similar to the primitive rhombs of quartz; it also occurs in pseudomorphous cubic crystals; but all these are rare; it is generally large botryoidal, or it forms layers in agate balls. The rarest colour is a light green, which only occurs in India.

Here is a small stalactitic specimen covered by quartz crystals, radiating from it, which is semi-transparent.

Mary. What is this very dark brownish mineral, nearly opake?

Mrs. L. That is carnelian in its natural state?

Mary. But are not all these in their natural state?

Mrs. L. All, except the dark red ones; they were originally like this, but have acquired their beautiful colour and transparency by exposure to heat: they are burnt in large earthen or iron pots; an operation which is performed before they are exported from India.

Frances. But carnelian is found in other countries, is it not?

Mrs. L. Yes, carnelian pebbles are abundant in Arabia, Surinam, Siberia, Bohemia, and many other places; they are mostly light red and yellow, (sometimes variegated,) and do not require burning. It is rather softer than calcedony.

Mary. Is this green mineral, calcedony?

Mrs. L. No; that is a substance called plasma; it is distinguished from the other subspecies by its greater degree of transparency and lustre.

Frances. What are those whitish dots in it?

Mrs. L. It is all plasma; but I cannot tell you whether they differ from the green part, in any respect besides colour.

Mary. Here is a specimen, like a piece of melted bottle glass; the external surface is quite bright.

Mrs. L. That is plasma from the ruins of Rome, where most of the specimens in collections have been found.

Frances. Here is a very large piece.

Mrs. L. No, that is heliotrope, commonly called bloodstone, from the red spots of jasper it sometimes contains; but these are not essential to it; it is an intimate mixture of calcedony and a substance called green earth, (which you will not see just yet.)

Mary. It is a much finer colour than plasma or prase.

Mrs. L. In general it is only translucent on the edges; but I have some beautiful specimens in which the mixture of the two substances is not complete; and being cut thin, they are very translucent. And here is one, where the

green earth is dispersed through the calcedony like moss. The colouring matter is iron.

Frances. These are very interesting.

Mrs L. The last I showed you was brought from Abyssinia, by lord Valentina. Heliotrope occurs in Bucharia, Tartary, Siberia, Scotland, and some other places. The Siberian varieties contain no red spots. Chrysoprase is another very beautiful subspecies of calcedony, which you will readily distinguish from every other mineral, by its colour.

Mary. What a refreshing green. Is this caused by iron?

Mrs. L. No; that colour is produced by the oxyde of nickel, of which it contains about one per cent.* The green is a little bluer than that of emerald. In fracture, chrysoprase resembles caledony, but it never has a botryoidal form, being always found in small veins, which it completely fills up, as you may see by the roughish brown exterior of these specimens.

Frances. I see some Egyptain pebbles. What are they called in mineralogy?

Mrs. L. They are jasper: another species in this large family, which is subdivided into several kinds. Here is a variety, which, from its resemblance to the Egyptian pebbles, has been called red Egyptian jasper though found only at Baden. The colour is in general a light brownish red.

Mary. Are these pebbles found any where besides in Egypt?

Mrs. L. No; they occur there, loose in the sand, and their original geognostic situation is unknown. Common jasper is generally massive, and frequently intersected by small veins of quartz, as in these specimens, which are Sicilian.

* Calcedony.		Carnelion.	Plasma.	Heliotrope	Chrysopras.
Silica	99	... 94.	... 96.75	... 84.	... 96.16
Lime		... —	... —	... —	... 0.83
Alumina		... 3.50	... 0.25	... 7.50	... 0 08
Ox. iron		... 0 75	... 0.50	... 5.0	... 0.08
Ox. nickel		... —	... —	... —	... 1.00
Water		... —	... 2.50	... —	... —
Loss	1	... 1.75	... —	... —	... 1.83

Frances. I had always fancied that jasper was red, like this; but I see you have some of a fine ochre yellow.

Mrs. L. Here are also brown and green; but the scarcest kind is black jasper: this substance is always opake or very slightly translucent on the edges. Jasper sometimes consists of alternate layers of different colours: that consisting of leek green and purplish red is found only at Orsk, in Siberia. Porcelain jasper is supposed to be a pseudo volcanic production: that is, it has been converted into a kind of porcelain by the action of heat, though it has not been melted in the manner of lava: it occurs in the neighbourhood of those places where volcanoes or beds of coal have burnt.

It is only the lead gray and lavender coloured specimens that have any degree of lustre: some of the red and yellowish varieties are dull.

Frances. It is ever found in England?

Mrs. L. Yes; it occurs in considerable quantity between Wednesbury and Bliston, in Staffordshire, one of the coal districts of England, but it is more abundant in Saxony and Bohemia. Jasper, when intimately mixed with quartz or caledony, is called agate jasper: it would perhaps be better to call it jasper agate, and to consider it as an agate, for it is not a simple mineral.

Mary. And is not agate a simple mineral?

Mrs. L. No: agates consist of flint, quartz, amethyst, calcedony, hornstone, jasper, heliotrope, and cacholong; and are differently named according to the different manner in which the substances are arranged; generally, only two or three occur together.

The principal kinds of agate, are striped, brecciated, fortification and moss agate. Striped agate is in general composed of jasper and calcedony; sometimes of jasper and amethyst

Frances. How very beautiful this is; the layers are so extremely thin and close.

Mrs. L. The largest and finest specimens of this kind are brought from Saxony, where there are very large veins of it. The middle of one of these veins contains this kind, called brecciated or ruin agate.

Mary. That is very curious: it is all composed of little pieces of striped agate and amethyst.

Mrs. L. It appears at first sight like an artificial spe-

cimen; but the parts have been actually broken and cemented together by nature. Fortification agates you have often seen: a great part of those called Scotch pebbles are of this kind.

Frances. Some of these are very much like plans of fortification; but those forms are much more distinct where the calcedony is transparent and the lines dark.

Mrs. L. In many of those dark agates, the colour has been produced, or at least deepened, artificially.

Mary. How is that done?

Mrs. L. I believe it is generally affected by boiling them in sulphuric acid.

Frances. But I thought that silica was not at all soluble in any of the acids?

Mrs. L. Neither is calcedony acted on by them; but agates consisting of different layers, often contain carbonaceous depositions of bitumen, which by exposure to acids, are in some degree burnt, and change colour, as any vegetable substance will, if acid be poured on it; particularly sulphuric.

Mary. Do agates then contain vegetable substances?

Mrs. L. Very often. In most agates, Dr. M'Culloch has discovered them, and even ascertained the genus to which they belong. Here is a thin slice of fortification agate, which I attempted to darken by heating it in acid, and you see that some parts have been completely dissolved.

Frances. Yes; here is a layer between those of white calcedony, which has been decomposed and left some openings in your specimen.

Mrs. L. I shall not detain you with these specimens now; you can examine them by yourselves equally well; and they will be an evening's amusement for you.

The last species nearly resembles flint: but though the fracture of small pieces is conchoidal or splintery, the structure of the large masses is slaty.

Frances. What is it called?

Mrs. L. This kind is called flinty slate; but there is a subspecies named Lydian stone, which is distinguished from it by its darker colour and opacity.

Mary. This black specimen, I suppose, is Lydian stone?

Mrs. L. Yes; but it is sometimes an extremely dark green. The colours of flinty slate are generally gray or

reddish brown, and it is often intersected by quartz veins. Lydian stone was formerly much used as a touch-stone, to ascertain the purity of gold and silver.

Frances. I do not understand how it could be useful for such a purpose.

Mrs. L. It is not by any chemical operation; but simply by drawing the metal across the surface of the stone, and comparing the colour of the trace with that of the pure metals, or alloys, which we know contain the proper proportion. These minerals are not quite so hard as flint. I am afraid you are tired of the quartz family, for it is the moss extensive in the whole system; but if any other contained as many species, it would not detain you so long as this, because I have explained many things to you from these specimens, which I shall not have occasion to mention again; and as siliceous substances, particularly quartz, occur with almost every other mineral, and under various appearances, I have made a very large collection of them.—To-morrow, we will look at the garnet family and some others.

CONVERSATION VII.

MRS. L.

YOU must not expect to see much beauty in the minerals of this family.

Mary. Does it contain many species besides garnet?

Mrs. L. Yes, several; but very few possess the fine colour which renders precious garnet fit for ornamental purposes.

Frances. These deep red crystals are, I suppose, precious garnet?

Mrs. L. Yes; the primitive form is the rhomboidal dodocahedron; but is very often modified by truncations on the edges. (Pl. IV., fig. 50 and 51.) This mineral, is said to be the carbuncle of the ancients. The species called pyrope, is often employed in jewellery; but it may be distinguished from precious garnet by its want of crystallization; it always occurs in roundish grains, which are sometimes imbedded.

Mary. What is this green mineral?

Mrs. L. That is a crystal of precious garnet, enveloped in chlorite; here is a similar one broken, which shows the small conchoidal fracture,* and shining lustre; these crystals sometimes occur the size of a fist.

Frances. But are these *precious* garnets? They are nearly opake, and the lustre of this one is quite metallic.

Mrs. L. They are not fit to be used as jewels; but they are considered as precious garnets in mineralogy; differing from the others in their depth of colour. The metallic lustre is occasioned by the quantity of iron contained in that one: in some countries, this kind, and the massive common garnet, are worked as ores of iron.

* The garnets of Canada and Greenland have a foliated fracture.

Mary. That is the reason, I suppose, that it is so heavy?

Mrs. L. Yes; the specific gravity of precious garnet varies from 4.08 to 4.3; that of common garnet is generally about 3.7. Common garnet crystallizes in the same forms as precious garnet; but the colour passes from nearly black, through various shades of brown and dull green, to a pale hyacinth red; the fracture is fine grained, uneven, and, except in some of the crystallized specimens, it is nearly opake.

Frances. Are these small bright yellow crystals, common garnet?

Mrs. L. No; that mineral is called, from its colour, topazolite; it was at first considered as a variety or subspecies of garnet; but it has been found to contain a small quantity of the earth glucine, and only 2 per cent. of alumina. It has only been found at Mussa, in Piedmont. All these minerals are sufficiently hard to scratch quartz.

Mary. What are these very little blackish crystals?

Mrs. L. They are pyreneite, on limestone; the form is the rhomboidal dodecahedron, and none of them are modified. These yellowish green translucent crystals, are called grossular garnets, or grossularia, from their resemblance, in colour, to a green gooseberry (groseille.)

Frances. How do you distinguish them from the green crystals of common garnet?

Mrs. L. The planes of the grossular garnet are with very few exceptions smooth; but those of the common garnet are streaked in the direction of the edges of the dodecahedron. Their composition too is very different; grossular containing above 30 per cent. of lime; in this respect, it resembles the next species, allochrorite, which you might at first mistake for massive common garnet.

Mary. Is it possible to find out with which of the two species a mineral should be arranged, without analysing it?

Mrs. L. Yes; allochroite is not so hard as quartz, and it is infusible before the blowpipe without the addition of phosphate of soda. When this is added, it melts into a kind of enamel, which is at first reddish yellow; afterwards, becoming greenish, and, at last, black. Precious and common garnet melt before the blowpipe pretty easily, and so does colophonite.

Frances. Is this granular mineral, colophonite?

Mrs. L. Yes; it very seldom occurs crystallized; generally consisting of numerous shining, angular grains, which are easily separated from each other.

Mary. In transparency and colour the grains have a good deal of resemblance to the light coloured precious garnet.

Mrs. L. But the specific gravity of this species is less than 3.0., which is a sufficient distinction.

Frances. Are not these black crystals pyreneite as well as the others?

Mrs. L. No; that is melanite or black garnet; pyreneite is more or less translucent, but this is always black and opake. It is remarkable that melanite rarely occurs in primitive dodecahedrons. I have *one* specimen from Sweden, in which they are not modified, but the crystals are small.

Mary. Are any of the other varieties scarce?

Mrs. L. Yes; allochroite has only been found at Drammen in Norway, and there not abundantly. Colophonite only in the vicinity of Arendahl in the same country. The pyrope was formerly called Bohemian garnet, from its locality. The finest precious garnets I know of at present, are some which were brought from Greenland, by Professor Giesecke, a few years ago; but very fine ones have been found in Bohemia, Ceylon, and Pegu.

The next species is aplome; it differs from the others both in composition and crystallization, though from its dull olive colour, it would appear to belong to common garnet. (Fig. 53.)

Frances. Are the angles of the dodecahedron never truncated in common garnet?

Mrs. L. Never; nor in any of the species except aplome; but the remarkable circumstance in this, is, that the planes of the crystals are always streaked in the direction of the shorter diagonals, which indicates the *cube* for the primitive form, though it has not yet been seen. The translucent crystals approach to a deep brownish orange colour.

Mary. What are these opake white crystals?

Mrs. L. They are leucite; a substance which has, perhaps, but little right to be placed here, as it differs from

all the other minerals in this family, in containing 20 per cent. of potash; but it is often arranged with these species, and called white garnet.

Frances. Are these the primitive crystals? (fig. 52.)

Mrs. L. Probably not: but it has never been observed to assume any other form; the trapezohedron* may be derived, either from the cube, or the rhomboidal dodecahedron as a primitive; but neither the surface, nor the fracture of leucite, will assist us in determining which of these belongs to it.

* This form has been termed the leucite crystal.

	Pyrope*	Precious* Garnet.	Com.† Garnet.	Topazolite.‡	Pyreneite§	Grossular*	Allochroite‖	Colophonite**	Melanite*	Aplome††	Leucite§
Silica	40.	35.75	39.66	37.	43.	44.	37.	37.	35.5	40.	56.
Alumina	28.5	27.25	19.66	2.	16.	8.5	5.	13.5	6.	20.	2.0
Lime	3.5	–	–	29.	20.	33.5	30.	29.	32.5	14.5	2.
Magnesia	10	–	–	–	–	–	–	6.5	–	–	–
Glucine	–	–	–	4.	–	–	–	–	–	–	–
Potash	–	–	–	–	–	–	–	–	–	–	20.
Oxyde of Iron	.5	36.	39.68	25.	16.	12.	18.5	7.5	24.25	14.	–
——— Manganese	.25	0.25	1.80	2.	–	Trace.	6.25	4.75	0.4	2.	–
——— Titanium	–	–	–	–	–	–	–	0.5	–	–	–
Water, &c.	–	–	–	–	4.	–	–	1.	–	–	–
Loss	1.25	0.75	–	–	1.	2.	3.25	0.25	1.35	7.5	2.

Mixture of Silica and Iron 2.

* Klaproth. † Hisinger. ‡ Bonvoisin § Vauquelin. ‖ Rose. ** Simon. †† Laugier.

Frances. Is this a trapp rock, in which the crystals are imbedded?

Mrs. L. No; that is lava, the most usual repository of leucite; so that it is considered as a volcanic production. Leucite is scarcely hard enough to scratch glass; a character which distinguishes it from a white mineral which has the same crystallization. You may have remarked, that all the crystalline forms of these species, are the rhomboidal dodecahedron, either simple or modified.

We now come to the idocrase family. The first species, idocrase or vesuvian, in composition resembles some of the garnets,* but the primitive crystal is a square prism. (fig. 54.)

Mary. Some of these are very complicated. (fig. 57.)

Mrs. L. I have endeavoured to arrange them with some attention to simplicity of crystallization—these detached crystals are but little modified, and very perfect.

Frances. Yes, the planes at both ends are quite smooth. (figs. 55, 56.)

Mrs. L. Those large blackish green ones are from the neighbourhood of the lake Baikal, in Siberia, whence they have been called Baikalite; but that name has been given to other substances from the same place. This mineral was first first found in the vicinity of Vesuvius; it is accompanied by carbonate of lime, mica, hornblende, common garnet, and sometimes other minerals. The pale green semi-transparent idocrase is from Piedmont.

Mary. Here is a bright blue specimen: is that idocrase?

Mrs. L. Yes, that is Norwegian: there is a pink substance imbedded in the quartz with it, which has not yet been analyzed, called tulite.

Frances. Surely, Mrs. L., *this* is not Vesuvian; it is exactly like one of the garnet family — colophonite, I think.

* Idocrase and cinnamon stone have been in general arranged in the garnet family; but the crystallization of idocrase differing from that of all the species of garnet, I have placed it at the head of a distinct family. It is followed by cinnamon stone, which Dr. Thomson considers as merely a variety of it. See Thomson's Chemistry, 6th Edition, Vol. iii. p. 291.

Mrs. L. Not *exactly*, though there is certainly a great similarity between the two substances; but, in composition, cinnamon-stone agrees with Vesuvian, rather than with garnet. For some years it was only known as occurring in the sand of the rivers of Ceylon, in the form of small rounded pebbles, which were thought to be a variety of hyacinth.

Mary. But, in these specimens, the cinnamon-stone seems to be intermixed with a white, shining substance.

Mrs. L. These are part of a rock in the Island of Ceylon, which was discovered a few years ago, consisting of cinnamon-stone, and a mineral called table-spar. I never heard of any crystals of cinnamon stone except one, in the collection of the Geological Society of Cornwall, which I have seen. It was sent from Ceylon by Dr. Davy the form is the rhomboidal dodecahedron.

Frances. Is it ever used as a precious stone?

Mrs. L. Yes, but it generally contains numerous very small air-bubbles, which give it the appearance of glass. The next species is Gehlenite, so named from Professor Gehlen, a celebrated mineralogist.

Mary. The crystals appear to be small rectangular prisms, but I am not sure about it—they are heaped together in such confusion.

Mrs. L. They are square prisms, (fig. 58.) but there are few minerals which resemble it—the entangled position of the crystals is rather characteristic of it.

Frances. Both your specimens are light gray; does it ever occur of any other colour?

Mrs. L. Yes; it is sometimes olive green, greenish brown, or bluish black—the fracture is uneven and dull. It is rather heavier than quartz—the specific gravity is about 2.91. Gehlenite will scratch glass, but is not so hard as quartz. The last member of this family is scapolite, of which there are three kinds; radiated, foliated, and compact.

Frances. Is there any other difference between them, than that of form?

Mrs. L. Very likely there is not—for the analyses of radiated and foliated scapolite are not more different than the results of different analyses of the same subspecies. The

largest crystals I have, are these long green ones, imbedded in carbonate of lime.

Mary. The prisms are very distinct; but I do not see any perfect termination. What is the primitive form.

Mrs. L. It is a square prism, (Pl. IV. fig. 59.) but it seldom occurs without modifications—the prisms in carbonate of lime, are octogonal. (fig. 60.)

Frances. Here is a primitive crystal, but it is full of cracks.

Mary. How silky the external lustre is—it looks a little like cat's-eye.

Mrs. L. That lustre is peculiar to the crystals that are nearly white;—in this specimen they are aggregated in little bundles. The compact scapolite, which is most commonly greenish gray, or pale olive-green, breaks with a splintery fracture; it sometimes occurs of a deep red colour, but this is rare.

Mary. What is this yellowish green specimen? it is translucent throughout.

Mrs. L. It is a variety called gabbronite; but it does not differ from scapolite, except in having rather more lustre and transparency. Scapolite has received several names; among others, Wernerite, in honour of the celebrated mineralogist Werner, and arctizite, from having been first found within the arctic circle.

Frances. In what part of the world does it occur?

Mrs. L. In the province of Wermeland in Sweden, where it is associated with carbonate of lime, and at Arendahl.*

	Idocrase*	Cinnamon stone*	Gehlenite†	Scapolite‡	Wernerite§
Silica	42.	38.80	29.64	48.	40.
Alumina	16 25	21.20	24.80	30.	34.
Lime	34	31.25	35.30	14.	16.5
Oxyde of iron	5.5	6.50	6.56	1.	8.
——— manganese	——	——	——	——	1.5
Water	——	——	3.3	——	——
Loss	2.25	2.25	——	5.	——

* Klaproth. ‡ Abilgard.
† Fuchs. § John.

Mary. I see we are at the end of the family; for here are some of my electrical friends the tourmalines

Mrs. L They are subspecies of schorl, (the first in the Schorl family,) which is divided into precious, or turmaline, and common schorl. These may, in general, be distinguished from each other, for common schorl is always black and opake.

Frances. All these brown, blue, and green crystals, then, are tourmaline.

Mrs. L. Yes, and the pink ones, which are sometimes called rubellite.

Mary. I recollect an immense specimen of rubellite in the Museum—the colour is pale pink, (not very bright,) and I think the crystals are arranged in a radiated form.

Mrs. L. Your description is very correct as far as it goes. It is one of the finest specimens of rubellite known, and is valued at 500*l.* You, perhaps, recollect a short history that is written under it, intimating that it was presented by the King of Ava, to Col. Symes; and it is mentioned by Col. S. in his entertaining account of the Embassy to Ava.

Frances. I recollect it now. Is the primitive crystal of tourmaline a prism?

Mr. L. No, it is a very obtuse rhomb, (fig. 61.) but the crystals are most commonly prismatic, and terminated by 3, 6, 9, or more planes—the flat terminations are very rare. I have a semi-transparent crystal of this form, (fig. 67.) partly imbedded in magnesian limestone, from Piedmont, the only place where this kind is found.

Mary. I should have thought it aqua-marine, or emerald, from its light colour.

Mrs. L. Here is a curious variety, of two colours.

Frances. The outside is green, and the middle bright pink, as if one had been put into the other.

Mary. And the crystals are cracked across in several places.

Mrs. L. Those are from North America. The crystallization of common schorl are exactly similar to these, and, in both varieties, the lateral planes are shining and deeply streaked longitudinally: but the planes of the terminations are generally smooth.

Frances. In some of these crystals the streaks are so deep; that I cannot tell how many sides the prism has; it appears almost round.

Mrs. L. That is a very common circumstance; tourmaline is sometimes radiated; but this is a variety seldom met with. Rubellite and common schorl are very frequently radiated.

Mary. Are these black crystals common schorl?

Mrs. L. Yes; those are from near Chudleigh, in Devonshire, and are imbedded in felspar—these more slender crystals, imbedded in white quartz, occur in Sweden. At Roche, in Cornwall*, there are rocks entirely composed of minute crystals of schorl, and roundish grains of white quartz. Common schorl, and the blue, green, and brown tourmaline, are coloured by iron: the red and violet varieties, by the oxyde of manganese, which, it, is supposed, is the cause of the infusibility of red tourmaline—the other kinds melt with very little difficulty.

Frances. Are these minerals harder than quartz.

Mrs. L. The hardness of quartz and tourmaline is about equal. Some crystals of tourmaline, which appear nearly, or quite, transparent, when you look through them, are opake in the direction of the axis—Here is a dark blue one, which is a very good example of this phenomenon. I have had it cut into the form of a cube, so that it is not the greater thickness of it in any direction that renders it opake.

Mary. How curious this is! looking in the direction of the axis, I cannot see the least light—what is the reason of it?

Mrs. L. It is caused by a property of the tourmaline, and many other minerals which have the power of producing a new arrangement in the position of the particles of light which fall on them, and are said to polarize them. Here is another substance that has also a very curious effect on light.

Frances. Is it not blue tourmaline?

Mrs. L. No; it is a much less abundant mineral, called iolite, or dichroite. In general it appears of a muddy

* Black schorl is desseminated through all the granites of Cornwall, from Mousehole to the Land's End.

violet, or indigo blue; but, if you look through it in the direction of the axis of the crystals, the colour is very different.

Mary. That is very surprising.

Frances. In this direction it is pale yellowish brown.

Mrs. L. I have some small crystals imbedded in a white mineral, apparently albite, from Massachusetts—some of them are light blue, and nearly transparent.

Mary. How could I distinguish them from blue tourmaline without detaching a crystal to see the two colours?

Mrs. L. The lateral planes of this substance are never longitudinally streaked as they are (with very little exception) in tourmaline, and the fracture is, generally, uneven: but, in tourmaline, it is conchoidal. The primitive crystal is a hexagonal prism (fig. 67.)—these are twelve-sided prisms. fig. 68.) This very dark blue variety is called indicolite.

Frances. The fracture is nearly radiated.

Mrs. L. The specific gravity, of both kinds, is about 2.5, and they will both scratch quartz with some difficulty. The massive, translucent iolite, is accompanied by pyrites.

Mary. Is this pyrites? it looks like brass.

Mrs. L. Yes; this mineral was formerly considered as blue quartz.

Frances. Here is a specimen that I think might be easily mistaken for quartz; it is quite transparent, and the fracture conchoidal.

Mrs. L. That is a subspecies called steinheilite: though it differs so very little from iolite, that some consider it merely as a variety. It occurs, as here, imbedded, or rather disseminated through a mixture of felspar, mica, and other substances, in small detached masses. I have never seen any that was not amorphous. There is another mineral of this kind, called peliom, which, both in composition and external character, appears to agree with iolite, so that I see no reason for making a distinction between them—it is said to occur only at Bodenmais, Bavaria.—Steinheilite is found in Finland. I do not think you will have much difficulty in recognising these minerals when you see them again—Axinite, the last species in this family, is also very well characterised. It is of a clove-brown colour, very

pale in some of the transparent varieties, and sometimes approaching to pearl gray; but the translucent crystals are deep brown, inclining to purple.

Frances. How very thin and flat the crystals are.

Mrs. L. It has been called axinite, in reference to its form, the edges being thin and sharp like that of an axe. The primitive, which is a right prism with rhombic bases (fig. 69,) has, I believe, been obtained only by cleavage. Some of the crystals are rather complex, but these are the most common. (figs. 70, 71, 72.)

Mary. The external surface is exceedingly brilliant though some of the planes are deeply streaked.

Mrs. L. Though it admits of cleavage, the indications of a foliated fracture, are very indistinct—the fracture is generally uneven.

Frances. I do not understand these crystals, they are so unsymmetrical.

Mrs. L. The want of symmetry in the crystalline forms of axinite, is accompanied, as in the tourmaline, by the property of becoming electric.—It is said that symmetrical crystals sometimes occur, which are not electric, but I have never seen any.—Small dark crystals occur in Cornwall, but I never saw any that exceeded three quarters of an inch in length, and they are uncommon of that size. The large transparent ones are from Dauphiné, and it occurs in Saxony and the Pyrenees.—the green colour

	Green Tourmaline*	Red Tourmaline*	Black Schorl†	Iolite‡	Axinite*
Silica - - - - -	40.	42.	36.75	42.6	44.
Alumina - - - - -	39.	40.	34.50	34.4	18.
Lime - - - - -	3.84	—	——	1.7	19.
Magnesia - - -	——	—	0.25	5.8	—
Potash - - - - -	——	—	6.0	——	—
Soda - - - - - -	——	10.	——	——	—
Oxyde of iron -	12.5	—	21.	15.	14.
——— manganese	2.	7.	Trace	1.7	4.
Loss - - - - -	2.66	1.	1.50	——	1.

* Vauquelin. † Klaproth. ‡ Dr. Leopold Gmelin.

and opacity of some of them is occasioned by the intermixture of chlorite.

Frances. Has the blow-pipe any effect on it?

Mrs. L. Yes; when it is heated (either alone or with borax) it melts into a hard black enamel. The epidote family, which follows, contains but two species, epidote and zoisite.

Mary. Are these large green crystals epidote? (figs. 74, 75, 76.)

Mrs. L. Yes; its most common colour is deep pistachio* green; and the large crystals and massive epidote, are only translucent on the edges; the primitive form is a right prism, of which the bases are oblique-angled parallelograms, (fig. 73,) but they are rarely, if ever, found without modifications.

Frances. The transparent crystals are streaked, like the tourmalines, but I do not think I should mistake one for the other—these are a much yellower green.

Mrs. L. The colour is not so good a distinction as the crystallization—you will not find it so easy to distinguish it from some varieties of idocrase, and this too has received the name of Baikalite, as well as some other appellations, thallite, pistacite, and acanticone.

Mary. What is this light green granular mineral?

Mrs. L. That is a variety of epidote, which is also called scorza; it differs from the other only in form. The light green spots on the surface of this specimen are aggregations of very delicate acicular crystals of epidote, radiating from a point.

Frances. They are as thin as hairs.

Mrs. L. Yes, it would be impossible to determine the crystallization. Here is a substance apparently very different from these, which is considered as a subspecies of epidote.

Mary. What is the cause, then, of its purplish brown colour?

Mrs. L. The oxyde of manganese, of which it contains about 12 per cent.—the crystallization and fracture are the same as in common epidote, but it is more opake, and is

* From the resemblance of its colour to that of the pistachio nut, it has been called pistacite.

not so hard, yielding to a knife. Common epidote scratches glass.

Zoisite very much resembles epidote in some respects, and the constituent parts are nearly the same, but its colour is generally blueish or yellowish gray, sometimes inclining to brown.

Frances. I think the fracture is brighter than in epidote.

Mrs. L. The most distinctive character of zoisite, is the manner in which the prismatic crystals are aggregated, like a parcel of reeds beside each other, and sometimes slightly diverging. It has but one cleavage, which is parallel to the axis of the prism, and in the direction of the shorter diagonal of the base.

Epidote.	From the Valais.	From Oisans.	Zoisite.
Silica	37.0	37.0	45.
Alumina . . .	26 6	27.0	29.
Lime	20.0	14.0	21.
Oxyde of Iron .	13.0	17.0	3.
——— manganese	0.6	1.5	—
Water	1.8	3.5	—
Loss	1.0	.0	2.

If your recollection of these minerals is pretty clear, we will just look at the pitchstone family.

Mary. I shall know them better after I have seen them once more at some other time; but at present, I confess so many green minerals have made something of a confusion in my head.

Mrs. L. Green is the most abundant colour in the mineral kingdom, except gray, therefore I do not wonder at your being a little puzzled with what you have seen; and it is only practice that will enable you to distinguish the different shades which appear nearly alike. However, there is but one green substance in this family—pitchstone.

Frances. What are these black specimens?

Mrs. L. Obsidian.

Mary. How exactly it is like black glass?

Mrs. L. Yes; and it has some resemblance to glass in its composition, containing from 7 to 10 per cent. of alkali; but this is not sufficient to render it as fusible as glass.

Mary. Will it not melt before the blow pipe?

Mrs. L. Some kinds will, but heat has a very curious effect on some obsidian: the black obsidian of Iceland melts into a pale gray vesicular glass; but that from Peru loses its colour entirely, becomes spongy and fibrous, and is converted into pumice.

Frances. What are the constituents that could produce this effect?

Mrs. L. It is most likely that gas is evolved, during the operation, but of what kind, has not been ascertained. This is rather an abundant mineral, and in some countries is applied to useful purposes. In New Spain and Peru, mirrors are made of it; and as it breaks readily into thin, sharp-edged pieces, the natives use it for razors.

Mary. They would have the advantage of retaining their sharpness longer than steel, I suppose?

Mrs L. Yes, but it is very brittle, so that little bits would soon be shivered from the edge. The natives of Easter Island make the points of their spears and arrows of obsidian; and it is found in Siberia, Iceland, and all volcanic countries. The blue and light gray obsidian is almost transparent—the blue variety is very rare, and found only in Mexico.—Obsidian scratches glass, but is not so hard as quartz. In some of the South American obsidian there is a silvery light, partaking of the colour of the mineral; this kind is much valued for snuff boxes and other ornamental purposes.*—It is sometimes striped like iron slag.

Frances. It looks exactly as if it had been melted.

Mrs. L. Many distinguished mineralogists, consider it as a volcanic production, and its being chiefly found in volcanic countries (and sometimes accompanied by lava,) seems to authorise this opinion, but others maintain its

* The Emperor of Russia, when in London, purchased small slabs of this substance for a snuff-box, for which he paid £300.

aquatic origin. It passes into pitchstone—you will see a good deal of resemblance between this mineral and iron slags.

Mary. Yes, here are some; but the lustre is not so great as that of obsidian, and it is more opake.

Mrs. L. The conchoidal fracture of pitchstone is in general less perfect than that of obsidian; and in those dark green ones from the island of Ascension, where it is the most perfect, there is a slight degree of roughness which is very peculiar.

Frances. Yes, but there is none of that roughness in this one.

Mrs. L. That is almost a slaty structure; it is from Newry in Ireland. In the pitchstone of the island of Arran, the fracture passes into uneven and coarse splintery; and a great deal of it contains little specks of felspar disseminated through it; and minute vesicular cavities.

Mary. I should have taken these yellowish and reddish white specimens for semi-opal.

Mrs. L. Pitchstone frequently passess into semi-opal, and sometimes into jasper, as in this ochre yellow specimen. Blue is by far the rarest colour of this mineral, and yellow pitchstone is rather scarce. It is found abundantly in Hungary and in Saxony; also in Ireland and Scotland, but not in England.

The next species is pearlstone.

Mary. Why is it called pearlstone?

Mrs. L. The specimens most characteristic of the species have a strong resemblance to grayish pearls, in their lustre, colour, and form. I should rather say, to a *mass of pearls;* for it consists of opake distinct concretions, in the form of somewhat angular grains, varying from the size of coarse sand to half an inch or more. If you examine those grains that are broken, you will see that they each consist of concentric coats or layers, like a bulbous root.

Mary. Yes; this is not like any thing I have seen, so I think I shall remember it.

Mrs. L. It is not like any mineral except spherulite; and it is sufficiently distinguished from that by its lustre, and the form of the grains.

Frances. Is this spherulite?

Mrs. L. Yes; the distinct concretions of this substance are always spherical, from which circumstance the name is derived.—Observe, too, that the specimen is not entirely composed of spherulite; but the little round masses are imbedded in pitchstone or pearlstone; sometimes singly, sometimes aggregated together. All these four species seem to be intimately connected; their composition is very nearly the same, and two or three of them are generally associated together. Pearlstone and spherulite are less hard than pitchstone. The blowpipe has a still more violent effect on pearlstone than on obsidian or pitchstone, causing it to become spongy and fibrous, and increasing it to many times its original bulk; for this reason it has been supposed that pumice was originally one of these substances, altered by the action of volcanic heat.

Mary. Is pumice found in volcanic countries?

Mrs. L. Yes; great quantities are exported from the Lipari Isles to England and other places; and it occurs in the Archipelago, Mexico, and Iceland. Common pumice you are acquainted with, but you have probably never seen the kind called glassy pumice.

Frances. From the name, I suppose *this* is it.

Mrs. L. Yes; you see the vesicular cavities are very round.

Mary. It is like a froth of soap suds, petrified.

Mrs. L. Gray is its only colour, but instead of having a faint silvery lustre, like the common pumice, it is strongly shining and vitreous. Dont't touch it; for it is extremely brittle—the specific gravity does not exceed 1.444, and sometimes is only 0.37, so that it will swim on water, like the vesicular quartz, till the air in the cavities is displaced.

	Obsidian.		Pitch-stone.	Pearl-stone.	Pumice
Silica	72.	7[illegible]	73.	77.	77.5
Alumina . . .	12.5	10.	14.5	13.	17.5
Lime	—	1.	1.	—	—
Oxyde of iron .	2.	2.	1.		1.75
—— manganese	—	1.6	0.1	2.	
Potash } . . .	10.	6.	—	—	—
Soda }			1.75	2.	3.0
Water	—	—	8.5	0.7	—
Loss	3.5	1.4	1.15	4. 1.3	0.25

CONVERSATION VIII.

MARY.

I BELIEVE the zeolite family is the next?

Mrs. L. Yes; and I think you will be pleased with it; for all the species occur crystallized, unless karpholite be excepted; but there is great reason to believe that all those shining delicate fibres are crystals.

Frances. Those radiated yellow tufts, then, are karpholite.

Mrs. L. Yes; it has never been observed of any other colour than deep straw yellow—the fibres are so minute and so easily separated, that its hardness is not known, but it is easily reduced to powder.

Mary. It seems to be opake.

Mrs. L. I believe it is completely so.

Frances. What effect has the blowpipe on it?

Mrs. L. It is almost infusible before the common blowpipe; owing, perhaps, to the quantity of manganese it contains; but the blowpipe, supplied with oxygen, melts it into a brown opake enamel. You will, most likely, never try the experiment, for it is a very scarce substance, having only been found at Schlackenwald, in Bohemia, and very sparingly.

Mary. Here are some more green minerals—what are they?

Mrs. L. Prehnite; it is of two kinds, radiated and foliated. I think you will not mistake the foliated prehnite for any of the green minerals you have seen.

Mary. No; this is a beautiful bright green, and not so blue as that of chrysoprase.

Mrs. L. The fracture, too, is very different—in one di-

rection it is foliated, and the folia a little curved; the primitive crystal is a rectangular prism (fig. 77.;) the most perfect example of this is the variety called koupholite, which is found in the valley of Barèges, in the Pyrenees.

Frances. How very thin these crystals are.

Mrs. L. When one dimension of a crystal is much less than the other two, it is said to be a table, or to have a tabular form. I have some very good ones which are nearly transparent, and of a greenish white colour. Some of the crystals are hexagonal. (Fig. 78.)

Mary. But Mrs. L., I cannot see any crystals in this large specimen.

Mrs. L. Not any *single* crystals—but you see the edges of a number of crystals closely aggregated. That kind is brought from the Cape of Good Hope, where it was first discovered by Col. Prehn, after whom it was named prehnite.

Frances. What are these small shining green masses adhering to the surface of this specimen?

Mrs. L. They are foliated prehnite; the concretions consist of folia diverging from a line, like the leaves of a book half open, so that the surface is somewhat cylindrical or conical, and the fracture is foliated and radiated. Fibrous prehnite is found at Glasgow, in the neighbourhood of Edinburgh, and at several other places in Scotland; the green is generally duller than that of the foliated kind; it consists of delicate acicular crystals, diverging from different centres: both kinds scratch glass, but this is rather the hardest; and they become electric by heat.*

Mary. Is this prehnite, too?

Mrs. L. No; that a is very scarce substance, called sodalite; it was first brought from Kanerdluersuk, in West Greenland, by Professor Giesecké, a few years ago, and has since been discovered on Vesuvius; its colour is always pale green, and it is, generally, crystallized in the form of garnet dodecahedrons, which are imbedded in white felspar: sometimes it is disseminated through it in small irregular angular masses.

* There is a mineral of a greenish white colour, and strongly translucent on the edges, found in India and Persia, which is generally known by the name of oriental jade, but is now considered to

Frances. Is it hard?

Mrs. L. It is about as hard as felspar; that is, intermediate between quartz and glass. There are several minerals, which, having a particular and unvarying degree of hardness, are very useful as fixed points in the scale, by which others may be compared. This mineral was named sodalite, by Dr. Thomson, who first analysed it, on account of the quantity of soda he discovered in it.

Mary. How much does it contain?

Mrs L. From 25 to 27 per cent. Natrolite was also named, from the quantity of this alkali, as one of its constituents.

Frances. How so?

Mrs. L. Formerly, soda was called natron. However, this is very different from sodalite; it is most commonly known as occurring in a botryoidal form, with a very compact fibrous fracture, and the fibres diverging.

Mary. And is it always of this ochre-yellow colour?

Mrs. L. Always when it is botryoidal; but there are, generally, narrow stripes of a lighter colour, which are parallel with the external form; the other kind is exactly similar in its appearance to the crystallized varieties of the two next species, skolezite and mesolite; they all occur in acicular crystals, which are, generally, four-sided prisms,

be a variety of prehnite; vases and handles of swords and daggers are made of it, which are much valued in the East.

	Karpholite	Foliated † prehnite	Radiated prehnite.	
Silica - - -	37.53	50.	42.875‡	43.60§
Alumina - -	26.48	20.4	21.500	23.00
Lime - - -	——	23.3	26.500	22.33
Magnesia - -	——	0.5	Trace	——
Oxyde of iron - -	5.64	4 9	3.	2.00
——— manganese -	17.09	——	.250	——
Water - - -	11.36	0.9	4.625	6.40
Loss - - -	1.90	——	1.250	2.67

* Steinman. † Hassenfratz, ‡ Gehlen. § Dr. Thompson.

terminated by four-sided pyramids. (fig. 79.) Sometimes two, sometimes all four of the lateral edges of the prism are truncated, and, occasionally, two edges of the pyramid. (figs. 80, 81, 82.)

Frances. But these bright transparent crystals are not acicular.

Mrs. L. No; but crystals of that size are very rare; the prisms are above the ⅛th of an inch in thickness. The most common form of these two substances is radiated aggregation of fibres, which are crystallized at their free extremities; but very often the conical, or wedge-like masses which they form, intersect each other, filling up all the little spaces in them, so that no crystallization takes place, as in these specimens.

Mary. Yes, like a number of stiff brushes.

Mrs. L. Both these minerals, the crystallized natrolite and the following species, Thomsonite, were, till lately, much confused together, under the name mesotype; but their composition being very different, they are now considered as distinct species. Skolezite, in place of the soda which exists in natrolite, contains lime; and mesolite appears to be a mixture of the two.*

Frances. But how can I possibly distinguish them, for these all appear very much alike, except that, in some, the fibrous fracture is more delicate and silky than in others? They are all radiated, pearly, and translucent, or semi-transparent.

Mrs. L. I do not know that it would always be possible without analyzing them unless you knew the locality of the specimens, which would materially assist you. The reflective goniometer can only be used when you have good and perfect crystals, as the cleavages are very im-

* The mineral, named ekebergite, appears to resemble mesolite, in composition, more than any other substance; but never having seen it, and being a scarce substance, I have not thought it necessary to place it in the system; it is composed of silica 46; alumina 28.75.; lime 13. 50.; soda 5.25.; oxyde of iron 0.75.; water 2.25.—3.50 was lost. It is described as a greenish gray mineral, translucent on the edges, having a two-fold cleavage, but never crystallized. Sometimes the fracture has a broad radiated appearance from the position of the folia: lustre, shining or glimmering, scratches glass, and strikes fire with steel. Specific gravity 2.746.

perfect. Skolezite, I believe, may be distinguished, from its twisting and curling when exposed to the blow-pipe.

Mary. I suppose then that they are all found in different parts of the world.

Mrs. L. That is not exactly the case; crystallized natrolite has only been observed at Burntisland in Scotland, Suabia, and at Auvergne. Skolezite, in Iceland, Staffa,* and the Faro Isles; and mesolite occurs in all these islands, and in Bohemia and the Tyrol. Thomsonite†, (so called by Mr. Brooke, in honour of Dr. Thomson, has been found only at Kilpatrick, in Dumbartonshire, and the crystallization is different from that of the other species. (fig. 83.) It is not uncommon to meet with some of these substances, deprived of their water of crystallization and then they are opake, without lustre, and have a powdery appearance, for which reason they have been called mealy zeolite.

The next mineral is stilbite, or foliated zeolite.

Frances. There seem to be two kinds of crystals on this specimen. Which is the stilbite?

Mrs. L. The thin hexagonal plates, (fig. 86.) the others are apophyllite; this is its most frequent form: but some-

* I think it very likely that the delicate hair, like fibres in the cavities of the basalt and trapp rocks of Ireland, are the same substance; being similar to the rocks of Staffa.

†	Natrolite.	Mesolite.	Skolezite.	Thomsonite.
Silica	48.0	47.0	46.5	36.8
Alumina	26.5	25.9	25.7	31.36
Lime	——	9.8	14.2	15.4
Soda	16.2	5.1	——	——
Water	9.3	12.2	13.6	13.0
Magnesia	-	-	-	.2
Peroxide of Iron	-	-	-	.6

The analyses of natrolite, mesolite, and skolezite, are the results of a series of experiments made by professors Fuchs and Gehlen, (which occupied them three years,) on the different kinds of zeolite, called by Haüy, mesotype, and by Werner, radiated, fibrous, and needle zeolite.

Angles of the prism of Natrolite, 91° 55′ and 88° 55′,—of Mesolite, 91° 25′ and 88° 35′,—of Skolezite, 91° 20′ and 88° 40′.

imes the crystals are larger, and thicker in proportion to their size. (fig. 85.) The primitive form is a rectangular prism. (fig. 84.)

Mary. How delicate and pearly the lustre is.

Mrs. L. Yes, that is very characteristic of it; the crystals, too, are generally a little curved in the direction of the only cleavage it possesses. It is very brittle, like all the other species, and when exposed to the action of the blow-pipe, they first froth violently, and afterwards melt into a white bead, nearly opake: and they gelatinize with acids; but stilbite does not, like the other species, become electric by heat.* Sometimes it forms little balls, the size of small peas, which occur along with the hexagonal plates.

Frances. Here are some trapezoidal crystals like the leucite. (fig. 90.) What are they?

Mrs. L. They are analcime;† but it is only this crystallization which resembles leucite; the primitive form is a cube, and here are crystals which are intermediate between the cube and the trapezohedron. (fig. 89.)

Mary. I recollect you said, that this form might be derived from the cube, as well as from the rhomboidal dodecahedron.

Mrs. L. Analcime is not always white, but often appears of a light ochre red colour; and chiefly in the numerous little cracks which appear on the surface.

Mary. It is very bright, notwithstanding those cracks. Has it any cleavage?

Mrs. L. Yes, in three directions, parallel to the planes of the primitive crystal: but the surfaces produced by cleavage are rather uneven. The specific gravity is 2.24: that of stilbite varies from 2.1 to 2.2; analcime becomes weakly electric by friction.

Frances. Is this analcime too?

Mrs. L. No, that is chabasite: the crystals are very different from those of analcime; the primitive form is a slightly obtuse rhomb, fig. (91.;) but they are more fre-

* The pyramidal end of the crystals, is the seat of the positive pole.

† Called also cubicite.

quently modified: fig. (92 and 93.)it is about as hard as analcime, scratching glass slightly, but softer than felspar: the crystals are generally small and colourless. Chabasite contains 21 per cent. of water, which is a greater proportion than in the other species: they both contain soda but only 2 or 3 per cent. of lime.

Mary. What are these curious white crystals, Mrs. L.? I do not understand them. (fig. 96.)

Mrs. L. That is a specimen of harmotome,* or cross-stone, as it has been called from its peculiar crystallization. Those are not single crystals, but are formed by the intersection of two similar to these. (fig. 95.) The primitive form is an octahedron, composed of two flat pyramids. whose common base is a square, (fig. 94.;) But I am not sure that this has ever been observed in nature; the twin crystals are the most common.

Frances. Here are some little scraps that have crumbled off the specimen: what shall I do with them?

Mrs. L. Do not throw them away; I will heat the shovel; and now you may throw them on it.

Mary. They are faintly phosphorescent.

Mrs. L. If there were more of them, you would see that the light is greenish yellow.

Frances. What is this mineral? It appears, at first much more transparent than it really is.

Mrs. L. It is called laumonite, in honour of Mons. Gillet Laumon, who first discovered it in the lead mines of Brittany: it is characterized by its peculiar silky lustre

*	* Stilbite. †		Analcime.†	Chabasite.†	Harmotome.‡
Silica - -	55.615	52.	58.	43.33	49.
Alumina - -	16.681	17.5	18.	22.66	16.
Lime - -	8.170	9.	2.	3.34	—
Barytes - -	—	—	—	—	18.
Soda - -	1.536	—	10.	9.34	—
Potash - -	—	—	—		—
Water - -	19.300	18.5	8.5	21.	15.
Loss - -	—	3.4	3.5	.33	2.

* Gehlen. † Vauquelin. ‡ Klaproth.

and reed-like form, though it is sometimes crystallized. (figs. 98, 99.) Both these specimens are gummed, though not sufficiently to disguise their own lustre.

Mary. Then why have you gummed them?

Mrs. L. Without that precaution they crack, and fall to pieces.

Frances. What is the reason of that alteration?

Mrs. L. It if most likely occasioned by the loss of part of the water it contains; for I believe that immersion in water will preserve it equally well. It is rather a scarce substance; so is dipyre, which occurs in this way dessemi-nated through a dark steatitic rock with pyrites

Mary. Are these little white masses crystallized!

Mrs. L. Yes; but the crystals are not very perfect. You may see indications of cleavage in some of them; it froths and phosphoresces before the blow-pipe

Frances. That is curious. Are these bright transparent crystals dipyre?

Mrs. L. No; they are a substance called meionite: some of the detached crystals are very perfect. figs. 100, 101.) The primitive is a square prism; but I believe this is only known from the cleavage and the analogy of the crystal to others derived from a similar primitive.

Mary. There are a great many other substances on this specimen?

Mrs. L. Yes; it is intermixed with mica, and other substances which are found on Monte Somma, and are generally supposed to be of volcanic origin. Meionite differs from all the other species in this family in containing a very small quantity of lithia.* This is the last species in the zeolite family.

* Laumonite.*		Dipyre.†	Meionite.‡	
Silica - - -	49.0	60	Silica - -	40.
Alumina - -	27.0	24	Alumina -	30.6
Lime - - -	9.0	10	Lime - -	22.1
Water - - -	17.5	2	Soda with lithia	2.4
Carbonic Acid	2.5	—	Ox. iron -	1.0
Loss - - -	—	4	Carb. acid & loss	3.1

* Vogel. † Vauquelin. ‡ Gmelin.

Frances. Let me see, the next is the lazulite family.

Mrs. L. Yes; it contains but two species, which are always blue.

Mary. This is lapis lazuli, is it not?

Mrs. L. Yes; it is called azure-stone; it is characterized by its brilliant azure colour.

Frances. It is an exquisite colour; I never saw any thing like it.

Mrs. L. Except the ultramarine, which is made from it.

Mary. That is the reason, then, that ultramarine is so much more beautiful than any other blue colour.

Mrs. L. The mode of preparing it is rather curious; perhaps you would like to know how the operation is conducted?

Frances. I should like very much to hear how the colour is obtained from it.

Mrs. L. The azure-stone is first reduced to a coarse powder and heated in a crucible for an hour; then vinegar is poured on it, and in that state it remains for some days. When the vinegar is poured off, the powder is rendered finer by rubbing it in a glass mortar: then it is repeatedly washed with water to free it from the vinegar, and ground on a porphyry or agate slab (in the manner of other colours) till it becomes an impalpable powder.

Mary. Then it is ready to be made into cakes?

Mrs. L. No; there is often a great deal of iron pyrites disseminated through it, which can only be separated from it by another process. The powder so far prepared is thrown into a melting mixture of pitch, wax, and linseed oil, and when they are thoroughly incorporated, the mixture is allowed to cool. Warm water is afterwards poured on this, and the whole is well triturated by means of a pestle and mortar: the water becomes muddy, and is poured off, and fresh water is added, which soon appears of a beautiful blue colour. The mixture is in this manner washed several times, the water being of a paler colour every succeeding time, till at last it only appears dingy gray. Each quantity of water being left to subside, blue powders are deposited of different degrees of intensity, and perfectly free from all the impurities, which remain combined with the cement.*

Frances. This is so strange a process, that I cannot imagine how any one happened to think of it. What is the colouring matter of lapis lazuli?

Mrs. L. It is not, I believe, yet determined; though many conjectures have been formed respecting it. It is found in rolled pieces in various parts of the east. Haüyne only occurs in a granular state, imbedded in lava: it is not at all like lapis lazuli.

Mary. No; I see it is transparent; of course it is a volcanic production. Is it found in all lava?

Mrs. L. No; it has only been observed at Auvergne, Andernach, and in the neighbourhood of Rome. Haüyne, in honour of whom it was named, calls it latiliate.†

The felspar family, which you will see now, is extensive, and contains some beautiful substances. Felspar itself is of several kinds; in its purest state it is called adularia, and occurs in beautiful white crystals (fig. 104, pl. V.;) some of which are nearly opake, and some semi-transparent.

Frances. One face of the crystal is deeply streaked in the direction of the longer diagonal; so, I suppose this is not the primitive form.

Mrs. L. No; the primitive form is an oblique rhombic prism of which the base is an oblique-angled paralellogram. (Fig. 102.) Adularai is generally crystallized; but sometimes it occurs massive, and frequently it is opalescent, as this polished piece.

Mary. That is beautiful. I think I have seen something like it before.

Mrs. L. Yes, I have a little piece set in a ring: you know it is called moonstone. These imbedded crystals are

	Silica.	Alumina.	Lime.	Sulphate of lime.	Oxyde of iron.	Sulphuric acid.	Potash.	Water	Loss.
* Lapis Lazuli.	46.	14.5	28.	6.5	3.0	—	—	2.0	—
† Hauyne.	30.	15.0	13·5	—	1.0	12.0	11.0	—	17.5

* Klaproth. † Vauquelin.

† The specific gravity of Haüyne, is 2.833 according to Gmelin; Neergaard makes it 3.10, and Gismondi 3.33. The specific gravity of azure-stone, is 2.7 to 2.9.

glassy felspar; they appear very much cracked in the direction of the longest side of the crystal: it is always of this light gray colour.

Frances. Here are some dark gray specimens too.

Mary. Oh, no! look at the beautiful colours they reflect; they are Labrador felspar.

Frances. So they are; but I could not see them at first. What is the cause, Mrs. L., of those beautful colours?

Mrs. L. They are produced by very minute shining scales or plates of a mineral called hypersthene.

Mary. But in that case it would be very much like avanturine.

Mrs. L. No, my dear; the scales of mica avanturine are always large enough to be seen without difficulty, and are disseminated through the quartz without any regularity; but in Labrador felspar, the hypersthene can very seldom be seen without the assistance of a microscope; or, when the scales are particularly large, with a strong magnifier; and they are arranged in the direction of the cleavage. These are specimens of common felspar, both crystallized and massive, (Fig. 105.)

Frances. There is a beautiful group of reddish crystals; there is a very peculiar glisten in the lustre of them, I have not observed in any other substance.

Mrs. L. You may observe the same kind of lustre on the cleavage surface in this flesh-red specimen. That crystal in your hand is a macle. (Fig. 108.).

Frances. What is the meaning of a macle?

Mrs. L. A crystal which appears as if it had been divided into two equal parts, and one of them turned half round. Suppose, for example, that I divide this crystal (fig. 106.,) at least the wooden model of it, which is made for the purpose, into two parts, by cutting it in the line, a, b, c, d, e. If I turn one part half round, and re-unite them, an angle will be formed at b. (fig. 108.) Do you see that clearly?

Frances. I think I do; but this can only take place in crystals that are unsymmetrical, at least when only the parts *diametrically opposite* are alike.

Mrs. L. You are mistaken, Francis, in your supposition, for the regular octahedron is frequently macled.

Here is a macled octahedron (fig. 141. pl. V.,) and a model which will explain it.

Mary. How curious! The section of the octahedron is a regular hexagon. (fig. 140.)

Mrs. L. Therefore, though in reality, one part is turned half round, it appears as if only turned one sixth of its circumference: this has three re-entering angles.

Frances. That is a very simple example. Are macled crystals of felspar common?

Mrs. L. They are not so plentiful as simple, or twin crystals?

Mary. What are twin crystals?

Mrs. L. They are crystals that occur two together, the one penetrating or intersecting the other. You may see numbers of them from one to three inches long, in walking over Westminister bridge, imbedded in the granite with which it is paved; they are mostly grayish white. Felspar is an essential part of granite, either in crystals or massive, and constitutes the greater of all porphyries; it is very abundant.

Frances. I think you said it was not so hard as quartz.

Mrs. L. No, but it is much harder than glass: if you try to scratch it with a piece of quartz, you will have some idea of the ease with which it may be done. You see two of the cleavages are very distinct; the third very imperfect; the fracture in that direction is uneven. One of the most uncommon colours is bright green: this kind is brought from the banks of the Amazon River, and is sometimes called Amazon stone.

Mary And what is this white earthy substance?

Mrs. L. It is felspar in a decomposed or disintegreted state: it is employed in the making of porcelain.

Frances. Can this be the same substance as those crystals?

Mrs. L. I believe this kind has not been analysed, but the difference of its texture is conjectured to arise from the loss of the potash, which is a constituent of common felspar.

Felspar, when compact, has so much the appearance of hornstone, that you might easily mistake one for the other; but a very simple experiment will enable you to distinguish them.

Mary. What is that?

Mrs. L. Compact felspar is fusible before the blowpipe, but hornstone is not. The specific gravity of these minerals is about 2.56. This granular mineral is called Indianite, from having been hitherto observed only in the Carnatic: it always contains those little blackish specks, which are hornblende. In hardness, it is intermediate between felspar and glass; these dark green crystals are called gieseckite, from professor Giesecke, who discovered them at Akullcarafiarsuck in Greenland; the hexagonal prism is the only form it is known to assume, at present, and its colour is deep green.

Frances. It seems to have a cleavage, parallel to the terminal planes.

Mrs. L. Yes, there is an appearance of that kind: but it is so scarce a substance, that I am unwilling to run the risk of destroying my specimen by making experiments on it. The light bluish green substance disseminated through this specimen, is called spodumen; you see it has a crystalline structure, but does not assume a regular external form.

Mary. Is it very different from felspar in composition?

Mrs. L. No, they are very similar, the principal difference is, that spodumen contains the newly discovered alkali lithia; the specific gravity is 3.1 or 3.2. Killinite and amblygonite are varieties of this mineral. Elaolite, (or fatstone,) also has a good deal of resemblance to some kinds of felspar. Dark bluish green is its commonest colour; but it is sometimes flesh-red or gray.

Frances. But it is more transparent than felspar of those colours, and the cleavage I think is less perfect.

Mrs. L. Yes; and the lustre is oily, which is the reason it is called fatstone. Both elaolite and spodumen occur imbedded in the Norwegian felspar; some of this resembles the Labrador felspar; but the only colour it reflects is a brilliant ultramarine blue. There is a mineral called Bergmannite, which also occurs in this rock; it is described as resembling both elaolite and scapolite in some respects, but is opake: these white crystals are apophylite. (Figs. 109, 110, 111.)

Mary. From their pearly lustre, I should have thought them some kind of zeolite.

Mrs. L. The substance has been called fish-eye-stone, from having that appearance. The primitive is a square prism, and the bases are more pearly than the sides.

Frances. Are not these, crystals of stilbite with them?

Mrs. L. Yes, they very often occur together; indeed, apophyllite is found in most of the localities of the zeolites. You will see by comparing the analyses, that all these minerals are composed of nearly the same substances combined in different proportions. The next specimen is petalite, the mineral in which lithia was first discovered.

Mary. It is extremely like fat quartz.

Mrs. L. Yes, but the hardness is not greater than that of felspar; and there is an indistinct appearance of a double cleavage.

Frances. Is it always white?

Mrs. L. No; you will see a tinge of red and green in some parts.

Mary. I should think it might be mistaken for many minerals.

Mrs. L. I do not think it is a particularly well characterized substance, but at present it is only found in the mine of Uton, in Sweden. This grayish green mineral is saussurite: there has been a good deal of confusion about the arrangement of it, in consequence of its having received the names of jade, felspath tenace, and variolite; it would, perhaps, be more correct to place it in the zeolite family, as it contains soda: but it has no external resemblance to any of the species, and as they have all a great deal of similarity, I have preferred this situation.

	* Adularia.	† Common Felspar.	‡ Compact Felspar.	* Indianite.	§ Gieseckite.	Spodumen. ‖	Spodumen. **	†† Elaolite.	‡‡ Apophyllite.	** Petalite.	§§ Saussurite.
Silica	64.	62.83	68.	42.5	46.0798	67.5	66.4	46.50	52.	79.212	49.00
Alumina . .	20.	17.02	19.	37.5	33.8280	27.0	25.3	30.25	–	17.225	24.00
Lime	2.	3.00	1.	15.0	–	0.63	–	0.75	24.5	–	10.50
Magnesia . .	–	–	–	–	1.2031	–	–	–	–	–	3.75
Potash	14.	13.00	5.5	–	6.2007	–	–	18.	8.1	–	–
Soda	–	–	–	–	–	–	–	–	–	–	5.50
Lithia	–	–	–	–	–	–	8.85	–	–	5.761	–
Oxyde of iron	–	1.00	4.	3.0	3.3587	3.	1.45	1.	–	–	6.50
—manganese	–	–	–	Trace.	1.1556	–	–	–	–	–	–
Water . . .	–	–	2.5	–	4.8860	0.53	0.45	2.	15.	–	–
Loss	–	3.15	–	2.0	3.2881	1.34	–	1.50	0.4	–	0.75

* Chinevix. † Vauquelin. ‡ Gordon St. Menin.
§ Stromeyer. ‖ Berzelius ** Arvedson.
†† Klaproth. ‡‡ Rose. §§ Th. de Saussure.

You see I am not always guided by the chemical properties.

Frances. No; but I should have been very much surprised to find this among the zeolites. What are these little shining plates, imbedded in it?

Mrs. L. They are schillerspar: saussurite and schillerspar frequently occur together, sometimes intimately mixed. Saussurite is much harder than felspar: some varieties will even scratch quartz, and it is extremely tough. The two species of the next family contain no lime; otherwise they differ less in composition from these than you might expect from their appearance.

Mary. Are they not mica?

Mrs. L. These are not; they are called lepidolite. It is very much like mica, perhaps it ought only to be considered as a variety; but, in general, lepidolite is either of this reddish lilac colour, or silvery white; the white is more opake then mica.

Frances. The scales of the white specimen are very large and less heaped together than in the lilac ones.

Mrs. L The white lepidolite is crystallized; those plates are hexagonal prisms—it has the same form as mica; the primitive is a rhombic prism. (fig. 112.)

Mary. I should like to see some crystals of mica. I thought it was only found in the form of scales and plates.

Mrs. L. These small deep yellow crystals are mica. (figs. 113, 114.)

Frances. How beautiful they are: quite a topaz colour; but I see the same kind of shining surface on the ends of them, as on the large laminæ.

Mrs. L. Mica is a crystalline substance which has but one cleavage; and that is so readily obtained, that the slightest effort separates the crystals into folia.

Mary. Then, perhaps, these large plates are parts of crystals.

Mrs. L. Certainly they are.—You may observe that most mica, (particularly the dark brown and gray varieties,) has a semi-metalic lustre. Black and pale pink are, I believe, the most uncommon colours. It is very easily scratched, even with the nail, but the particles of which it consists are so hard that the edges of the laminæ will scratch the hardest glass.

Frances. That is like charcoal: I recollect you said that it had the same property.

Mary. Is mica ever applied to any use?

Mrs. L. Yes; in Siberia, where it is abundant, and the folia large, the granite is quarried for the sake of the mica, which is used for windows, lanterns, and other purposes to which glass is applied in Europe. Specimens have been sometimes found above two yards square. This yellowish gray variety of mica has been called nacrite, from its strong degree of pearly lustre, which the French call *nacré*, but it does not appear to differ in any respect from mica.

Frances. And what is the specific gravity of these substances.

Mrs. L. That of mica varies from 2.6 to 2.79—the specific gravity of lepidolite is between 2.8 and 2.9.

Mary. I suppose there are no more species in this family.

Mrs. L. No; we now come to the slates;—the first is clay slate, a very abundant substance, which you, of course, know perfectly well.

Mary. O yes; this is exactly like the slates that we draw on.

Mrs. L. Some of the prettiest varieties are those found in Cornwall, where it is called killas: they are different shades of pink, lilac, gray, and light green; indeed it occurs there of almost every colour.

Frances. What occasions the green spots in some of the common slates?

Mrs. L. An intermixture of chlorite. The specimens following are whet-slate, which is known in commerce by the name of Turkey hone, and German hone.

Mary. They are used for oil-stones, I believe, to sharpen knives;—are they not, Mrs. L.?

Mrs. L. Yes; they are much harder than clay-slate.

Frances. Except this one, of two colours, they do not appear very slaty.

Mrs. L. Their structure, in great masses, is slaty, though the fracture of small pieces is splintery. The name whet-slate was first given to the green and gray varieties, from Turkey, but it is now applied to many other kinds of slate, which are sufficiently hard to be used for

sharpening knives—they are also called novaculate, from novacula, which, in Latin, signifies a knife. The one which you noticed, from its being partly of a yellowish colour and partly purplish-gray, is the German hone, and, in general, the colours are separated by a very straight line, where it often splits. The two species differs considerably in composition; clay-slate only contains from 38 to 48 per cent. of silica, but whet-slate, 72.

Mary. Are these brown specimens slate, too?

Mrs. L. Yes, they are alum-slate, from Whitby in Yorkshire—the black specimens are Norwegian—one of them, you see, contains minute acicular crystals of alum between the folia.

Frances. Is this like the large crystals of alum on the mantle-piece.

Mrs. L. Taste it.

Frances. Oh, no; that is sour, and not unpleasant, but this is very disagreeable.

Mary. It tastes like ink: what is the reason of that?

Mrs. L. Natural alum contains a small quantity of sulphate of iron, which is a principal ingredient of ink; but it does not exist in the alum of commerce—these little crystals do not always occur in alum-slate, but are the effect of efflorescence, after the specimen has been, for sometime exposed to the air.

Frances. I had no idea there were more than one kind of slate.—What do you call this piece?

Mrs. L. It is drawing slate; commonly, but improperly, termed black chalk; for it contains neither of the constituents of chalk—the fracture is often somewhat conchoidal, and earthy; it is soft, and easily cut into crayon pencils, for which purpose it is imported from Italy and Spain. It differs from the other species, in containing 11 per cent. of carbon, which causes it to mark so readily.

Mary. I have, generally, heard it called Italian chalk. —What are the little crystals on this specimen?

Mrs. L. They are sulphate of lime; but that is another kind of slate, called bituminous shale; it contains so much bitumen and carbon, that in the places where it is found, it is used instead of coal—it is generally blackish brown, and the fracture is very straight slaty. At Kimmeridge, in Dorsetshire, it is called Kimmeridge coal.

The last species, adhesive slate, you have already seen with menilite. It is sometimes arranged with the clay family; but from its compactness, and slaty structure, I see no reason for preferring that situation to this.

Mary. But, what is it composed of?

Mrs. L. Above one half of its weight is silica.

Frances. Then, why should it be arranged with the clay family?—there is no resemblance between it and clay.

Mrs. L. If the minerals, which are generally called clay, were chiefly composed of alumina, it would, doubtless, be very absurd; but, in reality, most of them contain more silica than alumina—nevertheless, even when this is the case, they present *the character of alumina*, being, in general, soft and friable—they are, therefore, placed in the siliceous genus, instead of the *aluminous*, which contains those minerals which are above half composed of alumina.

Mary. But, Mrs. L., has pure clay, I mean pure alumina, never been found?

Mrs. L. I believe not; it is always combined either with silica, or sulphuric acid and water, or all three.

Frances. Is this beautiful white earth, alumina and silica?

Mrs. L. Yes; it is called porcelain clay, from being used in the manufacture of porcelain—probably the proportions of the constituents vary in different specimens. That from Saxony is said to contain 52 per cent. of silica, 47 of alumina, and 9 of oxyde of iron;—it is very nearly like the disintegrated felspar, which is used for the same purpose: it feels very fine but not soft.

Mary. No, it has a harsh sandy feel.

Mrs. L. Potter's clay, on the contrary, feels soft and soapy, probably from the fineness of the silica which it contains.

Frances. Is not this something like pipe-clay?

Mrs. L. Yes, pipe-clay is the whitest and purest kind of potter's-clay.

Mary. Have you any clay, such as they make bricks of?

Mrs. L. Yes; it is generally, called loam—it varies considerably in its composition as well as its external appearance; being a mechanical mixture of sand and alumi-

na, and generally coloured by the oxyde and carbonate of iron. That in the neighbourhood of London is solid, and of a yellowish brown colour; but some loam, you see, is quite friable.

Frances. Yes; but, if it varies so much as this, I am afraid I shall not often know it when I see it.

Mrs. L. Knowing that it has not any *fixed* character, you will not look for any, but rather recollect the general composition of loam. There is one property, however, which belongs to all the substances in this family; when you breathe on them they emit a peculiar smell, which is called the argillaceous odour: you may try the experiment with this piece of clay-stone.

Mary. It is what you would call an earthy smell.

Frances. It is not unpleasant.—But what is clay-stone?

Mrs. L. It is merely clay in an undurated state. I do not know that it has been analyzed with accuracy, but it contains silica and alumina. It is tolerably hard; so that the fracture is nearly conchoidal. In Upper Lusatia there is a kind of clay very prettily variegated with lilac and different tints of yellow; but one of the most abundant kinds is the slate-clay or shale.

Mary. Is it this black, slaty mineral?

Mrs. L. Yes: it is always black, or nearly so; and very often petrifactions are found in it, both of shells and plants.

Frances. There are some beautiful petrifactions in this specimen, of leaves and stems.

Mrs. L. Ferns and reeds are the most common; some of the reeds are extremely large—the small plants generally lie in the direction of the strata, but the largest sometimes stand erect piercing the strata. One of this kind was observed in Nassau, 40 feet in height, and was a foot in diameter at one of the extremities. But, though there is great variety of them, none are like those now existing in a vegetable state—this mineral is found in beds contiguous to the bituminous shale.

Mary. I dare say I shall remember it.—What is this dusty looking substance?

Mrs. L. It is called rotten stone; I suppose from its friability. These pieces are from Derbyshire, where it is supposed to have been produced by the decomposition of

black limestone, which contains bitumen, and a good deal of alumina. Most of the limestone is removed by the process of decomposition: but sometimes solid pieces are found in the centre of masses of rotten stone. Put a drop of acid on this specimen.

Frances. It effervesces violently.

Mary. I suppose some of the bitumen must be lost in the decomposition, for the rotten stone is of a light gray colour, instead of being black like the limestone in the centre.

Mrs. L. Probably it has; and the mineral is porous and light.

Frances. Is it useful for any thing?

Mrs. L. Yes; it is used very extensively for polishing glass, and some of the softer precious stones; and the tea trays, and other articles that are japanned, are polished by means of rotten stone. Tripoli, which is applied to the same purpose, is arranged in this family, though it consists almost entirely of silica.

Mary. It is a good deal like clay stone, except in being so yellow.

Frances. Is it found in Tripoli?

Mrs. L Yes; it was first brought from that country, which occasioned its name: but it occurs in France, Tuscany, and several other places. This is another mineral also used for polishing, and called polishing slate; it is sometimes friable, and in large masses; the structure is slaty.

Mary. Oh, dear Mrs. L., I am afraid I shall be sadly puzzled when I see some of these minerals again; they are so much alike.

Mrs. L. Yet there is some difference in all of them. The polishing slate is distinguished from those it most resembles, by the alternate layers of white and gray, and by its lightness. But I do not by any means expect that you should remember all these the next time you see them, after looking over them so hastily. I think, however, that it would be of little advantage to you to spend a great deal of time on them now; another time you can examine them more particularly. But before we leave this family, I must mention to you a mineral called kollyrite, which is

remarkable from its containing nearly 42 per cent. of water.

Frances. What an extraordinary quantity; I wonder how it can be solid.

Mrs. L. It is white or reddish white, sometimes faintly translucent, and nearly dull. It is found in Stephen's pit, at Schemnitz, in Hungary. I will show you no more at present, for some of the minerals in the next family are so much like some of these, that you would perhaps be confused. I will give you the analysis of these clays, and, if you like, you can look over them again to-morrow, before we begin the lithomarge family.

	* Porcelain Earth.	†	* Potters Clay	‡ Common polishing-slate.	‡ Friable	§ Rotten stone	‡ Tripoli
Silica -	55	52	43.5	79	87	4	81
Alumina	27	47	33.2	1	0.5	86	1.5
Lime -	2	—	3.5	1	0.5	—	trace
Ox. of Iron	0.5	0.33	1	4	1.5	—	8
Water -	14	—	18	14	10	—	4.55
Carbon -	—	—	—	—	—	10	—
Sulph. acid	—	—	—	—	—	—	3.45
Loss -	1.5	0.67	0.8	1	5	—	1.50

*Vauquelin. † Rose. ‡ Bucholz. § Phillips.

CONVERSATION IX.

MRS. L.

I AM inclined to think that this family and the last, might very well form but one. However, most of these species contain a portion of magnesia, which is perhaps the best reason for separating them, though it may be an accidental constituent in some. Lithomarge itself is of two kinds; indurated and friable. The indurated lithomarge is frequently variegated with red, purple, and yellowish tints.

Mary. Are they occasioned by oxyde of iron, as in jasper, and some other minerals?

Mrs. L. Sometimes the colours may be owing to iron; but the crimson and purple of these specimens is caused by an intermixture of the sulphuret of mercury, which is, in fact, natural vermilion.

The fracture of indurated lithomarge is generally large conchoidal, and dull; but when it approaches to friable, it is scaly, and in some parts shining, as if it had been pressed by a polished surface.

Frances. That appearance seems to belong only to the specimens that are nearly white, and have a sort of fibrous structure. It appears to be very soft.

Mrs. L. It is so, and adheres to the tongue. This property belongs also to the next species, pimelite; it is distinguished by its green colour.

Mary. There seems to be a great variety of it, for you have it hard, and quite earthy, with all the intermediate states.

Mrs. L. Yes; it is probably only a variety of chrysoprase, as the colouring matter is oxyde of nickel, and both minerals occur together.

Frances. Perhaps, then, it is chrysoprase deprived of some of the water it usually contains.

Mrs. L. It has that appearance, certainly, but according to Klaproth's analysis of friable pimelite, it contains 38 per cent. of water, and chrysoprase contains none; so that it is difficult to account for the change that has taken place, if it were originally chrysoprase. The most friable specimens have a light yellowish green colour. They all feel rather greasy, as well as the lithomarge; formerly it was supposed, that all the minerals which had this greasy texture, contained magnesia; but pimelite does not contain two per cent. and many of the clays feel greasy, and figurestone, in which no magnesia has been discovered.

Mary. Is this carved specimen figurestone?

Mrs. L. Yes, it was called so from being used by the Chinese to carve images, vases, and other things, for which it is well adapted from its softness and sectility.

Frances. I have seen images made of this, but I don't think it is a very pretty.looking substance for the purpose; it is exactly like the rice figures.

Mrs. L. People have a strange mistaken notion, that nearly all the Chinese carvings are made of a composition of rice. Rice is sometimes used for the purpose, but the greater part are made of figurestone; generally greenish white, or brown; but a pale flesh-coloured variety is found in Transylvania. You may easily find out whether your carvings are made of this, or of rice, by scraping off a little and putting it on a hot shovel, or hot coals; the rice will smell like burnt bread.

Mary. I will try as soon as I go home. Are these little dark brown pieces, figurestone?

Mrs. L. No, they are mountain soap, a much softer substance; but some suppose that it is only a variety of the next species, bole: they are both very light, feel soapy, and adhere to the tongue; and very likely, yellow earth is another variety of bole. They all have, in a great measure, the appearance of clay; but the fracture of mountain soap, is not quite so dull as of the other, and the kind commonly called bole, is generally red.

Frances. I think, you once told me that yellow ochre was an earth—is it like this?

Mrs. L. It is precisely the same thing. Green earth

too is used as a pigment, and commonly called terra verte; it is very soft, but heavier than the other species, probably because it contains a good deal of iron. The specific gravity is 2.5 or 2.6; that of bole, from 1.4 to 2.

Mary. It is a fine deep green. I recollect you said it was the colouring matter of heliotrope.

Mrs. L. Here is a mineral which you have often seen.

Frances. Is it fullers earth?

Mrs. L. Yes: it was formerly much more extensively employed, than it has been since the invention of soap. All cloth, and woollen stuffs were cleansed from grease with this substance, by the fullers, from which circumstance it was named. The best kind is that found in England, and at one time its exportation was forbidden under very severe penalties. Cimolite, which took its name from the island of Cimolia, has been for ages employed in the same way, both there, and in the neighbouring countries.

Mary. Is this it, Mrs. L., with the impression of a seal on it?

Mrs. L. No; it is called Lemnian earth, from its locality in the island of Lemnos, where it is so highly valued that it is dug once a year on a particular day, in the presence of the clergy and magistrates, with great ceremony.

Frances. And what use do they make of it?

Mrs. L. It is used as a medicine, and has been celebrated ever since the time of Homer, as an antidote to poison and the plague. I believe it has not, in reality, the least power of doing good or harm; yet it is kept in the apothecarie's shops in Italy, and other countries.

Mary. How strange it is, the people should not have found out that it is of no use,—what is the composition of it?

Mrs. L. Nearly the same as that of fuller's earth: it contains rather more silica and less water. This is rather an unimportant family, so we will pass on to the hornblendes. The first three species, hornblende, actinolite, and tremolite, are in some respects so much alike, that many mineralogists consider them as varieties of the same substance, their difference being chiefly occasioned by the nature of minerals in which they are imbedded: but as this cause produces great difference of colour and even of composition, it will perhaps be better to divide them.

Frances. But would not the form of the crystals decide this question?

Mrs. L. Their crystallization has, ultimately, shown their connexion; but the first crystals of tremolite that were examined, not being very perfect, their angles were found by the common goniometer, (which was the only one then known,) to differ from those of hornblende and actinolite by, I think, two degrees: I speak of the angles of the prism, which was supposed to be the primitive form, for the *terminations* of the crystals were altogether different from those of hornblende. The examination of other crystals, has since proved that the primitive form of all the three species, is an oblique prism, of which the incidencies of the lateral planes are 124° 36′, and 55° 24′, by the reflecting goniometer.

Mary. From what you have said, I suppose these minerals pass into each other.

Mrs. L. Yes they do, in every respect. Actinolite is intermediate between hornblende, which is generally black. or very dark green, and tremolite, which is always a light coloured mineral. Actinolite is always green.

Frances. Are there many different kinds of hornblende, I mean the black kind?

Mrs. L. No: the massive varieties are called common and the crystallized basaltic hornblende; and sometimes when it forms beds in mountains, it has a slaty structure. The basaltic hornblende is opake, but the other kinds are sometimes faintly translucent on the edges particularly if the colour inclines to green. These crystals, (fig. 115. 116, 117,) are from Sweden.

Mary. It seems to have the same kind of glistening lustre that felspar has.

Mrs. L. In massive hornblende the structure is often fibrous, and then it resembles common schorl. Indeed you will often find it difficult to distinguish them.

Frances. But there is no glisten on schorl.

Mrs. L. No; but that is not always to be seen in hornblende; however, schorl is harder and more brittle. Hornblende is remarkable for its toughness. It is one of the most difficult substances to break that I am acquainted with; and if you intend to mineralize amongst hornblende rocks, you should get a strong hammer with a whalebone

handle, for a common one will very soon be destroyed. It is a very abundant mineral, being a constituent of some kinds of rock, as felspar is of granite.

Mary. There seems to be a good deal of diversity in the appearance of actinolite.

Mrs L. Yes; it is divided into granular, common, asbestous, and glassy actinolite. The granular kind occurs in crystallized grains imbedded in carbonate of lime; but they are generally a good deal rounded, and always translucent and green. It is sometimes called Pargasite, from being found at Pargas in Finland. Common actinolite is sometimes crystallized, but oftener fibrous, and in general the fibres are diverging. It has but little lustre, which distinguishes it from glassy actinolite.

Frances. Does glassy actinolite crystallize?

Mrs. L. Yes, those dark green crystals imbedded in talc are glassy actinolite; (figs. 118, 119.) the finest specimens of it are brought from Zillerthal in the Tyrol. Here is the asbestous actinolite.

Mary. It appears softer than the other kinds, and the fibres are curved and disposed in little tufts.

Mrs. L. One variety consists of small capillary fibres of a greenish gray, or very dull light green colour; and from its resemblance to amianth, it has been called amianthoide; but it differs from that in the flexibility of the fibres.

Frances. Are these minerals as hard as hornblende?

Mrs. L. Common and glassy actinolite are as hard, but more brittle; their hardness is intermediate between felspar and glass. Tremolite is chiefly found associated with calcareous and magnesian minerals: so that it contains a greater proportion of lime than the other species, but no alumina. Common tremolite is by far the most beautiful of the subspecies; it is frequently white, and you see the lustre of the fibrous varieties is very silky.

Mary. That is really beautiful: and is the lilac specimen of the same kind?

Mrs. L. Yes, but that colour is very rare; the crystals are generally greenish, (figs. 120, 121.) and sometimes gray, and slightly translucent. The glassy tremolite consists of long thin fibres, generally parallel, but often bent

or waved. I advise you not to touch these specimens, for the acicular fibres or crystals of which it is composed, are so exceedingly thin and sharp, that they easily penetrate the skin; and I once suffered great pain in my fingers for some days, in consequence of taking up a specimen of glassy tremolite.

Frances. I think the word glassy is very appropriate to this kind—are there any other subspecies?

Mrs. L. Yes; here is asbestous tremolite, and a more uncommon kind, compact—it was discovered in Scotland by Dr. Maculloch.

Mary. I should certainly have supposed it to be marble if I had found it.

Mrs. L. In external appearance there is some resemblance; but you will recollect that all marbles may be scratched with a knife, and will effervesce with acids, and this cannot.—It is like several other substances, and puzzled me a good deal the first time I saw it—the specific gravity of tremolite varies from 2.77 to 3.0. Actinolite from 2.5 to 3.4—the asbestous actinolite is the lightest. The specific gravity of hornblende is less variable; it is generally about 3.1. Besides all these divisions, particular varieties of hornblende have been distinguished by the names calamite and caranthine, which, I must say, I think unnecessary.

Frances. Then we have finished this family?

Mrs. L. No: it contains several other species. Diallage is the next; it may, I think, be divided into three subspecies; smaragdite, which is always green, and schillerspar and bronzite, which are generally brown; the two last are characterized by a semi-metallic lustre.

Mary. Is the smaragdite coloured by nickel? It is a beautiful green.

Mrs. L. No; the colouring matter is the oxyde of chrome: smaragdite forms a part of the rock known by the name of *verde di Corsica duro*, which is cut into slabs and columns; it is there intermixed with saussurite. Sometimes it appears to be almost granular. The schillerspar does not contain any chrome, but owes its dark olive colour to oxyde of iron. It is generally in the form of small roundish plates, imbedded in serpentine.

Frances. Does it crystallize? For I should suppose these surfaces to be produced by cleavage.

Mrs. L. I do not think it assumes any regular external form; but it has one very distinct cleavage—smaragdite has two; bronzite is very well characterized by its bright yellowish brown colour, and the fibrous appearance of the fracture.

Mary. It looks as if it might easily be reduced to thin fibres, and this gives it a sort of opalescent lustre.

Mrs. L. Yes: it is very pretty when it is polished with a rounded surface, like cat's eye: anthophyllite and hypersthène are very much like bronzite; here is part of a crystal of anthophyllite, imbedded in the same substance.

	Common Hornblende.*	Common Actinolite.†	Asbestus. Actinolite.‡	Glassy Actinolite.*	Common§ Tremolite.	Glassy‖ Tremolite.	Smaragdite.‡	Bronzite.‖	Schillerspar**	Anthophyllite.††	Hyperstene.‖
Silica	42.	64.	47.	50.	59.244	65.	50.	60.	52.	56.	54.25
Alumina	12.	2.7	—	0.75	0.888	—	11.	—	23.33	13.30	2.05
Lime	11.	9.3	11.3	9.75	15.200	18.	13.	—	7.	8.33	1.50
Magnesia	2.25	20.	7.3	19.25	22.133	10.33	6.	27.5	6.	14.	14.
Oxyde of iron	30.	4.	20.	11.	1.311	0.16	5.5	10.5	17.5	6.	24.50
Do. manganese	0.25	—	10	0.50	1.	—	—	—	—	3.	Trace
Do. chrome	—	—	—	3.	—	—	7.5	—	—	—	—
Do. copper	—	—	—	—	—	—	1.5	—	—	—	—
Potash	Trace	—	—	0.50	—	—	—	—	—	—	—
Water	0.75	—	—	—	—	—	—	0.5	—	1.48	1.
Do., with carbonic acid	—	—	—	5.	0.020	6.5	—	—	—	—	—
Loss	—	—	—	—	0.204	0.01	5.5	1.5	—	2.94	2.50

* Laugier. † Bergman. ‡ Vauquelin. § Hisinger. ‖ Klaproth. ** Heyer. †† John.

Frances. How could I know that this is not bronzite?

Mrs. L. It is harder and more brittle than bronzite; and, if you examine it, you will see indications of four cleavages: two are very distinct, but the others less so. This specimen, containing garnets and mica; is from Greenland—they mostly contain mica; sometimes intimately mixed with them.

Mary. And which is the hypersthène?

Mrs L. This dark brown mineral.

Frances. Surely, this has once been wood.

Mrs. L. No, I believe not; though it has so much the appearance of it, that I am not surprised you thought so: the colour is much darker than in the other species.

Mary. And the opalescence is quite a coppery colour. Is it harder, or softer, than the other species?

Mrs. L. It is a good deal harder, it will scratch common hornblende, and the specific gravity is 3.39—that of bronzite 3.2, and of anthophyllite 3.1. Hypersthène has been found on the coast of Labrador, either in rolled pieces, or imbedded in the felspar; and a variety was discovered by Dr. Macculloch in the Isle of Rum.

I consider the augite family, which is the next, to contain four species, though, as the primitive form is the same in all, some mineralogists call them varieties of *one*—but I think the division is convenient.—Sahlite and common augite are very much alike, and have a great resemblance to the greenish varieties of hornblende.

Frances. And these crystals (figs 122, 123,) are exactly like the basaltic hornblende.

Mrs. L. Not *exactly*, my dear; both the terminations and the angles of the prism are different; they are 87° 5′ and 92° 55′. The primitive rarely occurs, but it is determined by the cleavages, which in sahlite are easily obtained, but in augite, with some difficulty; consequently the surfaces so produced, are very flat and shining in sahlite; but in augite they are uneven, particularly in the direction of the terminal planes; and this is the principal difference between the two substances.

Mary. This, then, is a piece of sahlite?

Mrs. L. Yes: the crystals of augite are generally small. Those little black ones are found in lava.—Cocco-

lite is merely augite in a granular form—it is sometimes nearly black.

Frances. I see the grains are not imbedded in any other substance, but appear to be compressed together.

Mrs. L. It has less lustre than the other species, but its granular form is a sufficient distinction. Fassïte or pyrgomme appears to differ from common augite only in the form of its secondary or derivative crystals, which are generally terminated by pyramids, and in being of rather a lighter green; but I do not think it has been analysed.

Mary. Is there no difference in the hardness or specific gravity.

Mrs. L. No, they are all sufficiently hard to scratch glass; but some, rather feebly: and the specific gravity varies from 3.2 to 3.4. The surface of the crystals is generally shining, both in fassaïte and diopside, which is another species, and I think the prettiest of them—it is in general greenish white and semi-transparent.

Frances. I think it is a good deal like your French prehnite.

Mrs. L. Yes, but the crystallization is so different, that I hope you will never mistake one for the other. Diopside is generally accompanied by precious garnets of a bright hyacinth red colour, and greenish crystallized mica, which have together, a very pleasing effect. It was first called alalite by Bonvoisin, who found it at Ala, in the Piedmontese Alps, and he gave the name of mussite to a variety nearly opake, which he discovered in the Alp of La Mussa; it is of a grayer colour than the alalite, and the fracture sometimes appears slightly radiated.

	* Augite. †		Coccolite.†	† Sahlite. ‡		Diopside.§
Silica	48.	52.	50.	53.	54.18	57.
Lime	24	13.2	24.	20.	22.72	16.5
Magnesia	8.75	10.	10.	19.	17.81	18.25
Alumina	5.	3.33	1.5	3.	—	—
Ox. of iron	12.	14.66	7.	—	2.18	6.
— manganese	1.	2.	3.	4.	1.45	
Potash	Trace	—	—	—	—	—
Water	—	—	—	—	1.20	—
Loss	1.25	4.81	4.5	1.	0.40	2.25

* Klaproth. † Vauquelin. ‡ Hisinger. § Laugier.

Mary. There seems to be the same kind of connexion between these minerals that there is in those of the hornblende family; I mean hordblende, actinolite and tremolite.

Mrs. L. Precisely. You will see by the analyses that there is very little difference between them; not more than between the result of different experiments on the same species.

This is the last family in the siliceous genus: the next specimen is a hydrate of magnesia.

Frances. What is a hydrate? I do not recollect having heard of it before.

Mrs L. It means the combination of an earth, or other simple substance, with water; I say *combination*, because they must be chemically united, not mechanically mixed, which is the case also with the water in all those substances, of which it constitutes an essential part.

Mary. How very different it is from the common magnesia. This is quite pearly and foliated, like talc.

Frances. It seems curious, that being only magnesia, and water, it should be so compact—it is translucent, too. What is the specific gravity, Mrs. L.?

Mrs. L. It is 2.13. This is a rare substance, having only been found in two places; first, at Hoboken in New Jersey, and afterwards at Aust in Shetland, in small quantity. The next is the talc family: talc being the first species.

Mary. I recollect you told us that talc might be distinguished from mica by being flexible, but not elastic; but when the laminæ are so small as in this specimen, you would not be able to see whether they were elastic.

Mrs. L. Perhaps not: but talc and mica differ in other particulars as well as their degree of flexibility. If you try to scratch mica, you will feel a harsh grating sensation; but talc is very soft and soapy, yielding to the pressure of the nail, with ease; this is the case, even with indurated, as well as foliated and earthy talc; besides, the lustre is more pearly than that of mica: and, in general, the colour is white or green.

Frances. This is a beautiful bright green; but I do not see any large folia, like your Siberian Mica.

Mrs. L. No;-the laminæ of talc rarely exceed a few

inches in size. When it is crystallized, which is more rarely the case than with mica, it has the same form as mica. The substance commonly called French chalk, is indurated talc.

Mary. What occasions the soapy texture of these minerals?

Mrs. L. It is owing to the large proportion of magnesia they contain. Talc contains about 30 per cent. of this earth, and precious serpentine as much as 44 per cent.

Frances. I never heard before of precious serpentine. Here is a specimen like your green slab, which I used to think was marble.

Mrs. L. That is *common* serpentine; and the minerals commonly called Portsoy and Mona marble are varieties of it. You will see specimens of both kinds there. Some of the most beautiful pieces are from the Lizard rock in Cornwall. Precious serpentine has no colour but deep green, and is more translucent than common serpentine. When cut into thin slices, some parts are transparent, and others nearly black.

Mary. That is very pretty, but is it the same substance as this?

Mrs. L. Yes: excepting that this yellowish green variety is softer, and has a more conchoidal fracture. Both kinds are harder than common serpentine, and have a faint glimmering lustre.

Frances. I think you said that the white spots and veins in serpentine, were marble, or carbonate of lime.

Mrs. L. In the green slab which we were speaking of, but not in all serpentine: in the Cornish, for instance, they are steatite; a substance which is very frequently intermixed with it. You can have no idea of the beauty of the serpentine rocks at the Lizard point, and the neighbouring coves, without seeing them: they are variegated with the most brilliant greens, and different tints of brown and red, and intersected by large veins of steatite which are generally yellowish white, intermixed with purple.

Mary. I think I can imagine their magnificient appearance from these specimens.

Mrs. L. Here are some of the steatite from the same district, but it is rather in a friable state; that from Saxony

is more compact; from its remarkably greasy feel, it has been called soapstone. Probably earthy talc passes into steatite: indeed, there is a considerable resemblance between all the species of this family. This grayish green mineral, called potstone, appears at first to be a kind of serpentine; but the magnesia which it contains, is in the state of carbonate,

Mary. Is there any particular reason or calling it potstone?

Mrs. L. Yes; on the shores of the lake Como, where it occurs abundantly, quarries of this mineral have been worked for many centuries; it is there turned and cut into pots, jars, and various culinary vessels, which are very refractory in the fire, and consequently are used for the same purposes as our metal saucepans; and they have the advantage of not being soluble in any liquid. Ovens are often lined with it; and I have a tea pot, and part of a breakfast set, made of potstone.

Frances. It must be a valuable article in that part of the world.

Mrs. L. Yes; the vessels made of it are there an article of commerce, and are sent into the neighbouring countries. Its specific gravity is 2.88.

Mary. Here is a specimen so much like precious serpentine, that I almost suspect you have, by mistake, put it in a wrong place,

Mrs. L. Your suspicion is not very surprising, but if you try the hardness of it, you will soon be convinced of the difference. Jade will scratch felspar, and serpentine is softer than glass, and this is a remarkably tough substance; for which reason, it is very much valued by the natives of the South Sea Islands, (where it is principally found) who form it into hatchets and knives. I have no doubt that this has been a hatchet. Most of their carvings are performed by instruments of jade. It is always of a deep sea-green colour.

Frances. That is a beautiful piece indeed. What is this Mrs. L.? it is like talc.

Mrs. L. That is foliated chlorite; its crystallization is very peculiar; the little blackish masses disseminated over that specimen, consist of a number of thin, hexagonal la-

minæ, aggregated so as to form frustrums of two cones, applied base to base. (fig. 126.)

Mary. That is really very curious; but the crystals on this specimen are different.

Mrs. L. They are produced in the same way; only that in these, the axis passes through *two opposite* angles of the laminæ. Some of them are split, and show the arrangement of the laminæ. (fig. 127.) Chlorite is not often crystallized, but generally appears to consist of small scaly parts, like talc: when it is more compact, it is often slaty, and sometimes earthy.

Frances. Is not the earthy chlorite, the kind that occurs in rock crystal?

Mrs. L. Yes: and it is not always green, like the other subspecies, but sometimes brown and gray: nearly one half of its weight is oxyde of iron—all chlorite contains a good deal, which seems to be the principal difference between it and talc.

Mary. Is not this asbestus, Mrs. L.?

Mrs. L. Yes; it is flexible asbestus, or amianth.

Frances. I remember seeing some in the British Museum, and some cloth made of it, which it is said was used formerly for wrapping up the dead bodies before they were burnt.

Mrs. L. It was exceedingly well adapted for this purpose, as it consists of long silky fibres, which resist a great degree of heat: it scarcely melts before the blowpipe. It is so abundant in Corsica, that it is used instead of tow, or wool, to pack minerals with; and a great deal was, at one time, found in quarrying the Anglesea serpentine; the workmen would not believe it was a mineral, but said it was cotten.

Mary. I suppose they thought it was petrified.

Frances. Is not this another kind of asbestus?

Mrs. L. It is common asbestus, which only differs from amianth in its greater hardness, and want of flexibility: the prettiest varieties, I think, are this sulphur-coloured specimen, and the bright green which occurs in the serpentine of Cornwall. The indurated kind has so much the appearance of wood, that it is called ligniform asbestus.

Frances. Yes, except that besides its woody appearance, it seems to contain a quantity of shining flakes.

Mrs. L. those shining parts are talc intermixed with it. The structure of all these varieties is fibrous: in this variety the fibres are curved, and it is said to be promiscuously fibrous. They are all soft and tough.

Mary. What is this, Mrs. L.? It is uncommonly light.

Mrs. L. It is another subspecies, called rock cork: you see there are some little fibres of amianth intermixed with it.

Frances. It is a very curious mineral. I suppose it is quite porous.

Mrs. L. Yes; it will float on water. Here is a variety, not less curious, called rock leather.

Mary. Oh! now you are quizzing, I am sure: it is a bit of an old glove.

Mrs. L. Take a magnifying glass, and examine this end of it: or you may light the candle, and try whether you can burn it.

Mary. I do see some indications of fibres.

Frances. And it really is incombustible! see, it is only become white.

Mrs. L. The only difference between this and common amianth, is, that *here*, the fibres are very much interwoven so that they cannot be separated.

Frances. I should like this family much better if some of the minerals were crystallized.

	Talc.*	Common †Serpentine.‡		Precious Serpentine.§	Steatite.*	Potstone.‖	Axestone.**
Silica	62.	31.5	44.	43.07	59.5	39.	50.5
Magnesia	30.5	47.25	44.	40.37	30.5	16.	31.0
Alumina	—	3.	2.	0.25	—	—	10.
Lime	—	0.5	—	0.5	—	—	—
Oxyde of iron	2.5	5.5	7.3	1.17	2.5	10.	5.5
——— manganese . .	—	1.5	1.5	—	—	—	—
——— chrome	—	—	2.	—	—	—	0.05
Potash	2.75	—	—	—	—	—	—
Carbonic acid	—	—	—	—	—	20.	—
Water	0.5	10.5	—	—	5.5	10.	2.75
Volatile matter	—	—	—	12.45	—	—	—
Loss	1.75	—	—	2.19	2.	—	0.2

* Klaproth. † John. ‡ Vauquelin. § Hisinger. ‖ Tromsdorf. ** Kastner.

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Mrs. L. They are in general so well marked, that if they possessed a crystalline form, it would not, perhaps, be their most distinctive character. Steatite, however, sometimes appears in pseudo crystals, similar to those of quartz, (fig. 36,) and I think this is by far the most remarkable instance of pseudo-crystallization; for both the terminations are perfect, and there is nothing to account for the removal of the quartz by decomposition.

The two next minerals belong to the chrysolite family; there is little difference between them, except that chrysolite is crystallized, and olivine, granular.

Mary. I believe chrysolite is a precious stone, is it not?

Mrs. L. Yes; but it is less valued than some others, which are not more beautiful, from its comparitive softness.

Frances. Is it softer than amethyst?

Mrs. L. Yes, it is intermediate in hardness between amethyst (or quartz,) and felspar; the primitive form is a rectangular parallelopiped (fig. 128,) but it seldom occurs; this crystal is more common (fig. 129.)

Mary. The lateral planes, I see, are streaked longitudinally: but if I were to find a small fragment without any trace of crystallization, how could I know it?

Mrs. L. I think it would not be difficult to distinguish it from the minerals it most resembles, tourmaline beryl, and grossular garnet. It is softer than any of them, and is not electric by heat.

Frances. I think the colour would be almost a sufficient distinction, it is such a beautiful bright yellow green.

Mrs. L. Do not depend too much on that; it is sometimes a brownish yellow, and is very much like some of the phosphate of lime: olivine was named from its light olive colour, and at present we know of no other. It is neither quite so transparent, nor quite so hard as chrysolite, though it contains more silica; the colouring matter is iron.

Mary. And what is the specific gravity of these two minerals?

Mrs. L. Chrysolite is 3.4; olivine 3.2, or nearly 33. I forgot to tell you that chrysolite becomes electric by friction. Now, I think you have seen quite as much as

your memory will retain till we meet again; we shall then look at the ruby family, the first in the aluminous genus.

	Silica.	Magnesia.	Lime.	Oxyde of iron.	Loss
* Chrysolite -	39.	43.5	——	19.	——
† Chrysolite -	38.	50.5	——	9.5	2.
* Olivine - -	50.	38.5	8.25	12.	——

* Klaproth. † Vauquelin.

CONVERSATION X.

MRS. L.

I EXPECT that you will be much delighted this morning Frances for you will scarcely see any mineral which does not crystallize. The first species is corundum, which is of three kinds; the transparent varieties are called sapphire; the crystallized and massive ones, which are *not* transparent, corundum, and the granular corundum is emery.

Frances. So that you have a complete transition from these beautiful transparent crystals, to a dirty brown sand.

Mrs. L. Yes; but the emery you have seen, is not in its natural state; it is ground and washed. You know, I believe, that next to diamond, sapphire is the hardest substance in nature; it is nearly pure alumina.

Mary. A short time ago I should hardly have believed any one who might of told me so; but it is not more wonderful than that the diamond should be nearly the same substance as charcoal. What is the primitive form of sapphire?

Mrs. L. A slightly acute rhomboid (fig. 130,) which very seldom occurs; but may be obtained by cleavage; at least from corundum. The most common form is a hexagonal prism, or double acute hexagonal pyramid, which often exhibit parts of the primitive planes, or faces produced by other modifications (figs. 132, 133, 134.) You will find some of these little red sapphires nearer to the primitive, than any of the other crystals (fig. 131.)

Frances. They are very perfect indeed; but—

Mrs. L. But what, my dear?

Frances. I was going to make a foolish observation

about the colour ; I remember now, you said that sapphire was of almost every colour.

Mrs. L. Yes ; the red sapphires are called oriental rubies, and are easily distinguished from the spinel rubies by their hardness and the specific gravity, which varies from 3.9 to 4.2 ; that of spinel not exceeding 3.8. Green is the most uncommon of its colours ; but all sapphires of a pure colour are very much valued, on account of their hardness and brilliancy. The crystals of corundum are similar to some of the sapphire crystals ; but they are generally of a brownish gray colour, and opake, or nearly so.

Mary. These are very large crystals ; do you know where they were found.

Mrs. L. Yes ; near Madras, imbedded in granite ; the corundum from the carnatic, is generally of a light greenish gray colour, imbedded in Indianite, and it occurs sometimes blue and red, but these colours are seldom bright, though the red always inclines to crimson.

Frances. Here is a specimen, Mrs. L., of a delicate pink and blue, is it corundum ?

Mrs. L. Yes ; that is a variety from Piedmont, which was discovered but a short time ago. In India, where it is rather plentiful, it is burnt and powdered, and used instead of emery.

Mary. Which is native emery, Mrs. L. ? I mean emery in its natural state.

Mrs. L. There are two kinds ; this dark brownish gray variety is the most common ; it has a sandy appearance ; but the other is very compact, with an uneven or splintery fracture ; the granular emery contains a good deal of the oxyde of iron.

Frances. I do not admire either of them. Pray what is this very pale green crystal ?

Mrs. L. It is chrysoberyl, another precious stone.

Mary. It is much paler and yellower than chrysolite, and some of these fragments are opalescent.

Frances. Yes ; there is a bluish floating light, like that in moonstone.

Mrs. L. The primitive form is a parallelopiped nearly similar to that of chrysolite, and the secondary crystals are not very different, (figs. 135, 136 ;) it is scarcely infe-

rior to sapphire in hardness, and the specific gravity is generally 3.6.

Mary. I suppose if I could not take the specific gravity of it, the conchoidal fracture would distinguish it from sapphire, which always seems to break in the direction of the cleavage.

Mrs. L. That is a sensible idea, Mary; but chrysoberyl *has* cleavages in two directions, though they are difficult to be obtained; and sapphire is not so easily cleaved as corundum. The spinel ruby, except a variety of a blue colour, had been always found in crystallized grains; till, very lately, small pink spinels were discovered in Ceylon by Dr. J. Davy, imbedded in white marble.

Frances. Are not the blue spinels in grains?

Mrs. L. No; here are some as large as peas, very well crystallized, and imbedded in a similar kind of marble: they are found in Sweden; and the loose crystals, in the sand of Ceylon, along with sapphires, chrysoberyls, and other substances in round and crystallized grains.

Mary. These are a dull purplish blue: I suppose they are never cut and polished like the red spinels?

Mrs. L. No; they are not sufficiently transparent, even if the colour were good; but the Indian spinel is not always red; it is sometimes nearly colourless, and often yellowish and greenish white, or pale purple; but mostly transparent. This and the two next substances, ceylonite and automolite, crystallize in the form of the regular octahedron, which is their primitive, and in other forms derived from it (fig. 137, 138. 141.) The small dark green crystals on this specimen are ceylonite; but they are not very easy to see, being so much intermixed with mica, and other minerals.

Frances. But they are very brilliant, and almost black.

Mrs. L. The crystals of ceylonite are in general *very* small: those of automolite are larger, and are dull deep blue.

Mary. These substances are both very different from spinel, though they have the same form.

Mrs. L. They are both softer than spinel. The principal difference between them, is, that spinel derives its beautiful red colour from the oxyde of chrome; and auto-

molite contains from 24 to 28 per cent. of the oxyde of zinc; the rest is chiefly alumina.

Frances. The specific gravity of automolite I suppose is greater than of the other two species.

Mrs. L. Yes; it is as high as 4.2. and 4.6—spinel varies from 3.5. to 3.8. Ceylonite is about 3.7. or 3.80. Andalusite, the last species, has no external resemblance to the others of the ruby family; but I have placed it here ou account of its great hardness, and because it consists principally of alumina.

Mary. Is it as hard as spinel?

Mrs. L. Perhaps they are about equally hard; but the hardness of andalusite is rather variable:—the crystals are rectangular prisms.

Frances. These are very large and perfect; but you cannot see the colour of them, they are so completely covered by scales of—mica, I believe.

Mrs. L. Yes; it always occurs with mica, though not always enveloped in it:—it is generally light gray, and sometimes of a flesh red, inclining to lilac; with very little lustre, and an indistinct appearance of cleavage, parallel to the lateral planes of the prism. Andalusite, and all the other substances of this family, are infusible before the blowpipe. The next specimen is nepheline—it has been called infusible felspar.

	* Sapphire.	† Corundum.	* Corundum.	‡ Emery.	† Chrysoberyl.	† Spinel.	‡ Spinel.	§ Antomolite.	‖ Ceylonite.	‡ Andalusite.
Alumina . .	90.	84.	86.50	53.83	71.5	74.50	82.47	60.	68.	52.
Silica . . .	7.	6.5	5.25	12.66	18.	15.50	—	4.75	2.	32.
Lime . . .	—	—	—	1.66	6.	0.75	—	—	—	—
Magnesia . .	—	—	—	—	—	8.25	8.78	—	12.	—
Oxyde of iron	1.2	7.	6.50	24.66	1.5	1.50	—	9.25	16.	2.
Do. chrome	—	—	—	—	—	—	6.57	—	—	—
Do. zinc. .	—	—	—	—	—	—	—	24.25	—	—
Potash . . .	—	—	—	—	—	—	—	—	—	8.
Water . . .	—	—	—	—	—	—	—	—	—	6.
Loss . . .	1.8	2.	1.75	7.19	3.	—	2.18	1.75	2.	—

* Chenevix. † Klaproth. ‡ Vauquelin. § Collet-Descotils. ‖ Ekeberg.

Mary. There are several substances here,—which is nepheline?

Mrs. L. The transparent colourless crystals; they occur with meonite, and, in general, the same specimen contains them both:—you may easily distinguish them by their crystallization. The nepheline has the form of hexagonal prisms, and sometimes they are very low, so as to appear tabular. A variety, consisting entirely of these little plates, confusedly heaped together, has been called ice-spar. This family contains another mineral called Bucholzite*, which I have not seen.

Frances. What is the composition of nepheline?

Mrs. L. It consists of nearly equal parts of silica and alumina. Bucholzite is a pure silicate of alumina; that is, the silica is chemically combined with the alumina, as an acid might be; indeed, silica is considered, in many cases, to act the part of an acid, and such compounds are called silicates. In the next family are three substances, topaz, pyrophysalite, and pycnite: they differ a good deal in appearance, but very little in composition.

Mary. I should not have supposed that: this is very much like white felspar.

Mrs. L. That is pyrophysalite; it is rather harder than felspar, and the specific gravity is about 3.4:—besides, when it is exposed to the action of the blow-pipe, it bubbles a great deal, but is infusible so that you may easily distinguish them. It is only found at Fahlun, in Sweden. But you have not looked at the topazes—here is a great variety of crystallization.

Frances. So I perceive; but what is the primitive form? for I like to begin with that.

Mrs. L. The primitive form of topaz is not yet satisfactorily ascertained. It has been supposed to be a rectangular octahedron, (fig. 142,) or a rhombic prism, (fig. 143,) the secondary crystals may be derived from either; but the only cleavage which can be obtained, is parallel to the bases of a prism. You see that in all these fragments, two opposite parts present perfectly flat and shining surfaces.

* From Bucholz, a celebrated chemist.

Mary. And in every other part, the fracture is small conchoidal. I suppose all these are parts of crystals.

Frances. Are topazes usually crystallized?

Mrs. L. Yes; they are sometimes very much rounded, particularly those from New South Wales and Brazil; but always have a perfectly crystalline structure. In Siberia, the crystals occur in groupes, with quartz crystals. In Saxony, topazes are an essential part of a rock called topaz-rock: it consists of quartz, topazes, both massive and crystallized, and schorl, which is disseminated through it in small particles; and the crystals have in general a single terminal plane (fig. 146) perpendicular to the axis.

Mary. But there is only one end to that.

Mrs. L. Topazes with two terminations are rare: when the two ends are crystallized, they are generally dissimilar, and such crystals are electric by heat. The Siberian topazes are generally terminated by two large planes, forming an edge, and four or more smaller ones, (figs. 145, 147.;) these little ones are from Saint Michael's Mount, in Cornwall, and those crystals from Brazil (fig. 144.)

Frances. Are they found in a great many places?

Mrs. L. Yes; it is the most widely distributed of the precious stones: its specific gravity is scarcely less than that of spinel, but it is not so hard; this is useful to know, because some red topazes resemble spinel so much when cut, that it is very difficult to distinguish them.

Mary. Where are these beautiful rose-coloured ones found?

Mrs. L. They are Brazilian; but that is not their natural colour, it is produced by exposing the deep yellow topazes to a considerable degree of heat for some hours; topazes, however, sometimes occur of a fine deep red colour. Pycnite does not occur in perfect crystals, but consists of thin prismatic concretions, which are sometimes hexagonal, and it has a cleavage across the prisms, but not perpendicular to their axes.

Frances. I think I should have taken it for some kind of schorl, from its structure.

Mrs. L. It has been improperly called schorlaceous beryl, from its structure. The only colours of pycnite are pale lilac, and light straw and sulphur colour; it is

translucent on the edges, and about as hard as pyrophysalite. These three minerals contain fluoric acid; but the proportion of it to the other components is so variable, that they are not usually included in the class of acidiferous minerals.

Mary. Those blue specimens, I suppose, belong to the cyanite* family, which I believe is the next.

Mrs. L. Yes; but it contains other substances besides cyanite, and blue spar; cyanite I think is a beautiful mineral. The blue colour is so brilliant, and it has a very pearly lustre, particularly one variety, which appears quite opalescent, and has been named sapparite. I should tell you that cyanite is also called sappare; and by Haüy, disthène, from the circumstance, that some of the crystals acquire positive, and some negative electricity, by friction: it crystallizes, (fig. 149, 150.,) but is only lamellar in one direction—parallel to two of the lateral planes.

Frances. The crystals are very bright, and some of them nearly transparent.

Mary. There is a radiated specimen too; and what is this, Mrs. L., it is very much like cyanite, except that the colour is reddish white?

Mrs. L. All those radiated specimens are rhætizite; here is one of a gray colour intermixed with black; the black colour is said to be caused by an intermixture of plumbago.

* Pronounced kyanite.

	* Topaz.	†	† Pyrophysalite.	† Pycnite.	‡ Cyanite.	§ Blue-spar.	‖ Fibrolite.	* Grenatite.	** Pinite.
Alumina	48.	58.38	57.74	51.	55.	74.	58.25	47.	63.
Silica	30.	34.01	34.36	38.43	30.	14.	38.00	30.6	29.5
Lime	—	—	—	—	2.	3.	—	3.	—
Magnesia	—	—	—	—	2.	5.	—	—	—
Potash	—	—	—	—	—	0.25	—	—	—
Fluoric acid	18.	7.79	7.77	8.84	—	—	—	—	—
Oxyde of iron	2.	—	—	—	6	0.75	—	15.3	6.75
Water	—	—	—	—	—	5.	—	—	—
Loss	2.	—	0.13	1.73	5.	1.	3.75	41.	0.75

* Vauquelin. † Berzelius. ‡ Saussure. ‖ Chenevix. ** Klaproth.

Frances. What is plumbago?

Mrs. L. It is the substance commonly called black lead. Rhætizite is sometimes light red. In the British Museum, there is a small crystal of cyanite, about three quarters of an inch in length, enclosed in a piece of transparent quartz. In general, it is imbedded in talc or mica slate.

Mary. Is this compact mineral, cyanite?

Mrs. L. No; that is blue spar. The blue is lighter, and it has not the purple tinge which distinguishes cyanite; it is only translucent on the edges, and the fracture splintery; the specific gravity is 3. Blue spar has only been discovered in the valley of Murz in Stiria. Fibrolite is still more scarce; it was first observed by Count de Bournon, imbedded in indianite.

Frances. It is called fibrolite, I suppose, from its structure. It is extremely similar to some of the radiated zeolites.

Mrs. L. Yes; but this is harder than quartz, and infusible before the blowpipe. The next species is grenatite or staurolite: you have already seen some crystals of it.

Mary. I do not remember them.

Mrs. L They occur in the talc slate, with the crystals of cyanite.

Frances. I recollect I was going to ask you what those reddish brown prisms were, when Mary inquired about the rhætizite.

Mrs. L. The twin crystals of this mineral are remarkably pretty; they sometimes intersect each other at right angles (fig. 153,) and sometimes obliquely (fig. 154.)

Mary. Those are very curious; but the edges are not so sharp as in the little single crystals (fig. 152.)

Frances. Here is a gray crystal; is that grenatite?

Mrs. L. No; it is pinite: it is very much softer than grenatite; indeed they have scarcely any resemblance, except that they both occur in hexagonal prisms; this one has twelve sides (fig. 155;) internally the colour is reddish, mixed with green.

Mary. It is a good deal like mica, except that it appears to be opake.

Mrs. L. Yes; its cleavage is the same as that of mica;

but it is much less perfect; and pinite is easily broken in every direction. The next is the zircon family—it includes zircon, hyacinth, and eudyalite, which would be arranged with the garnets, if it did not contain 10 per cent, of zirconia.

Frances. Does it crystallize in the same form as garnet?

Mrs. L. Yes, generally in the form of the dodecahedron, sometimes with the edge truncated; part of this specimen is crystallized; it is imbedded in sodalite.

Mary. It is more of a lilac colour than garnet.

Mrs. L. Yes, that is the chief difference in their appearance. The specific gravity is 2.9. I am surprised that it is not heavier; for zirconia is the heaviest of all the earths; the specific gravity of zircon and hyacinth varies from 4.5 to 4.7. There is, in reality, no difference between these two substances; their composition and primitive form are the same. (Fig. 156.) Those crystals which are red, or reddish brown, are called hyacinth, and they are in general similar to these, (figs. 158 160.) These crystals, (figs. 157, 159,) are called zircon or zirconite.

Frances. It is curious that the crystallization should vary with the colour; are the zircons of any other colour besides brown?

Mrs. L. Yes; in Ceylon, where both species occur, they are greenish or bluelsh gray, yellowish white, and sometimes colourless. The red hyacinths are also found in France, and the zircons in Norway. Here is a crystal in zircon-syenite, nearly an inch long, and a quarter of an inch in diameter; it is one of the largest I have ever seen.

Mary. These gray ones are not at all pretty; are they ever cut?

Mrs. L. Yes; very frequently. They are employed in watch jewelling, and are often substituted for diamonds; they resemble them in having a very greasy lustre, even when polished; but they are not so hard as spinel ruby, and rather brittle.

Frances. The lustre is very peculiar; I think I could

distinguish them even without taking the specific gravity.*

Mrs. L. I need not tell you the name of these crystals.

Mary. No; I shall always know emeralds when I see them, their colour is so peculiar.

Frances. I remember you said that the green of the emerald was produced by chrome, but it is far more beautiful than the colour of smaragdite.

Mrs. L. I believe if smaragdite were as transparent as these emeralds, you would not find much difference between them. Emerald and beryl appear to be exactly the same substance, except that the colouring matter of the beryl is iron—their primitive form is a hexagonal prism; but it is very frequently modified, (figs. 161, 162, 163, 164.)

Mary. Is this yellow crystal a beryl?

Mrs. L. Yes; that colour is not common, they are usually of a blueish or sea-green colour, for which reason they have been called aqua-marine, which is still their most common name.

Frances. How could I distinguish a yellow beryl from topaz, if they were both cut.

Mrs. L. By its specific gravity which does not exceed 2.78; topaz is above 3. and it is not quite so hard as topaz.

Mary. Will you be so good as to show me how this crystal is derived from the primitive. I cannot understand it. (fig. 165.)

Mrs. L. That is not a beryl, my dear, but a crystal of euclase; its primitive form is an oblique rhombic prism.

*	Silica.	Zirconia.	Lime.	Soda.	Oxyde of iron.	Oxyde of manganese.	Muriatic Acid.	Water, or volatile matter.	Loss.
* Zircon .	33.	65.	— —	— —	1.	—	—	—	1.
† Hyacinth	31.	66.	— —	— —	2.	—	—	—	1.
‡ Endyalite	52.4783	10.8968	10.1407	13.9248	6.8563	2.5747	1.0843	1.8010	—

* Klaproth. † Vauquelin. ‡ Stromeyer.

I believe the primitive crystal has not been yet found in a natural state, but Dr. Wollaston has determined, from its cleavage, that the angles made by the lateral planes are 115° 10′ and 64° 50′. I am not surprised at your thinking it a beryl; its colour and the channels on the lateral planes, give them a good deal of resemblance, and it contains glucine. When they were first brought to England, they were sold for green topazes, but their crystallization is very different, and it is distinguished both from topaz and beryl, by its great frangibility: it has several cleavages, but the one most easily obtained is in the direction of the shorter diagonals of the prism.

Frances. Are none of these minerals found in England?

Mrs. L. No; euclase is found in Peru and Brazil, the very sparingly, and in isolated crystals. Emeralds are at present only brought from Peru; but it is conjectured that the ancients, who valued them very much, procured them from Ethiopia; they are rarely found imbedded in quartz and micaceous slate; an impure variety of a greenish yellow colour, and nearly opake, has been discovered at Limoges. Beryls are far more abundant and widely distributed; they are frequently imbedded in granite, or occur in groupes, connected by iron ochre: they have been discovered at Cairngorm in Scotland, and the county of Wicklow in Ireland.*

Mrs. L. This other specimen does not belong to the emerald family, which is the last of the earthy minerals; but it is a singular substance, and has not been analyzed.

Mary. It seems to consist of very small white crystals, disseminated through slate.

Mrs. L. Those crystals are chiastolite, or hollow spar:

*	Alumina.	Silica.	Glucina.	Lime.	Oxyde of Iron.	Oxyde of Chrome.	Oxyde of Tin.	Water.	Loss.
* Emerald	16.	64.5	13.	1 6	—	3.25	—	2.	—
† Beryl .	15.	68.	14.	2.	1.	—	—	—	—
‡ Euclase	30.56	43 32	21.78	—	2.22	—	0.70	—	1.42

* Klaproth. † Vauquelin. ‡ Berzelius.

if you examine them, you will find that they are really hollow, and filled by the same kind of slate as that they are imbedded in. (fig. 166.)

Mary. That is very curious: is this always the case?

Mrs. L. Yes; but, in this larger crystal, the black substance within it extends to the corners of the prism. (fig. 167.)

Frances. That is a beautiful crystal: it seems to contain five black prisms. I am delighted with this, because it is not like any thing else.

Mrs. L. There are a few other minerals, which, from not being analyzed, have not yet been arranged in any system, such as humite, chrichtonite, and melilite; but they are very unimportant, and I have not all of them, so that I think we had better proceed immediately to the acidiferous earthy class, beginning with those substances which consist of *lime* united to an acid.

Mary. It is found combined with several acids; is it not?

Mrs. L. Yes; the carbonate of lime is the most abundant of its combinations, and perhaps the most abundant of all simple minerals. There is scarcely any country in which carbonate of lime may not be found, either in the form of limestone, chalk, marble, or calc spar. The family of carbonates may be divided into three parts: the first eight species are nearly pure carbonates; the others are magnesian and argillaceous.—But I think we had better defer the examination of this genus till to-morrow; it is so extensive.

CONVERSATION XI.

MRS. L.

THE first species of carbonate of lime is called slate spar, from its structure.

Frances. I should have thought it foliated, rather than slaty; for it appears to have a crystalline structure, though it is opake.

Mrs. L. Its foliated structure is not owing to cleavage, but to an uninterrupted crystallization. The direction of the folia, (which are frequently curved,) is perpendicular to the axis of the primitive rhomb. The real cleavage may be seen at the edges of some of the laminæ. When thrown upon hot coals, it phosphoresces with a pale yellow light.

Mary. It appears to be very tender.

Mrs. L. Yes, it is; but the next specimen is much more so; it will not bear being handled.

Frances. How very silvery it is, like talc.

Mrs. L. It is called aphrite, or earth foam; and the name would apply equally well to the next species; rock milk.

Mary. This has a very different appearance; it is quite dull and earthy. I should have taken it for chalk.

Mrs. L. You will find them very different if you compare them. Rock milk and aphrite are very light: some varieties will float on water. It is supposed to be a deposition from the mountain streams, which pass over limestone rocks; and in Switzerland it is very abundant, and is used for whitening houses, and other purposes to which chalk is applied in England. That is chalk.

Frances. I never saw any chalk like this: I thought it was always white and soft.

Mrs. L. What you have generally seen is *whitening*; that is, chalk pounded and diffused through water, and the fine part of the sediment dried. By this process, the siliceous particles which it contains are separated, and the remainder is whiter and less compact than chalk in its natural state: it is generally yellowish or grayish white.

Mary. Is not this common limestone, Mrs. L?

Mrs. L. Yes; all those gray and yellowish specimens are common limestone; and it is called *compact* limestone, in distinction to some other kinds. The fracture is various; but generally, large flat conchoidal, and splintery.

Frances. But carbonates of lime are easily known, I suppose, by their effervescence.

Mrs. L. Yes, and they may be all scratched with a knife.

Mary. Is not marble a compact limestone?

Mrs L. Marble, is of two kinds; compact, or having an imperfect crystalline structure, which is called foliated granular. The gray marble of Plymouth, spotted and veined with red, is compact: it contains abundance of organic remains. The gray marble of Derbyshire consists almost entirely of petrifactions.

Frances. I remember there is a large table in the saloon of the British Museum, which is made of it. I mean the top of the table.

Mrs. L. The petrifactions are often vulgarly called screw-stones. Other marbles contain shells: the most beautiful of these is the kind found at Bleiberg in Carinthia; it is called lumachella or fire marble, from the beautiful colours it reflects.

Mary. That is almost as brilliant as opal.

Frances. Is this compact limestone?

Mrs. L. No: it is called roe stone, from its resemblance to the roe of a fish.

Mary. It is exactly like it, in colour and every respect.

Mrs. L. You would not suppose from its appearance, that it is one of the best building stones in the world; the finest is quarried at Ketton, in Northamptonshire. You will have little to examine in the calcareous spar, or foliated limestone, except the crystallization which is more various than in any other substance. Comte de Bournon,

in his elaborate treatise on this mineral, has enumerated fifty-six modifications, which, differently combined, furnished him with above 690 varieties of form.

Frances. What an astonishing number!

Mary. It is difficult to imagine how so many planes can be situated.

Mrs. L. There can be no doubt, however, that they exist, as the Comte has drawn them from the crystals in his own collection, and has calculated the decrements by which they are produced. Some of the most simple forms you have already seen; the primitive rhomb, (fig. 168,) the equiaxe, (fig. 170.) the hexagonal prism, the metastatic dodecahedron, and the dog's tooth crystal; it is rather remarkable that most of the fine calcspar of Derbyshire is of a deep topaz yellow colour, like these large crystals; and that found in Leicestershire, is quite colourless, and the crystals generally small.

Frances. Here are some of a beautiful light yellow, but the crystals are not perfect.

Mrs. L. They are acute rhombs aggregated together, and you only see one half of them. That is from Alston Moor, (fig. 176.) Comte de Bournon mentions fourteen acute rhomboids. This one (fig. 173,) is called the inverse rhomb, because the plane angles are the same as those of primitive, but the rhomb is acute.

Mary. That is a curious circumstance; but what are these crystals, Mrs. L.? not carbonate of lime, surely.

Mrs. L. It is called Fontainebleau sandstone; but is in reality carbonate of lime, which has entangled a great quantity of fine white sand; the crystals are inverse rhombs, which do not appear to differ from those of pure carbonate, except that the surface resembles that of sandstone.

Frances. How very strange that is! but I suppose this is not a chemical combination, or the crystallization would be different.

Mrs. L. Your observation is very correct; the sand, and carbonate of lime, are only mechanically mixed. I dare say you remember a large transparent rhombic fragment of calcspar in the British Museum, which is placed over a card with "double refraction" written on it.

Mary. O yes, perfectly; and the letters appeared as if written twice.

Frances. Somebody said it was Iceland spar.

Mrs. L. It is often called Iceland spar; though all carbonate of lime has the same property of showing two images of any thing placed behind it; but, probably this was first observed in the large transparent fragments which are found in Iceland; this is a very good specimen.

Mary. If you turn it round, one of the two lines appears to move, till at last they form but one.

Frances. How do you account for this property?

Mrs. L. I am afraid, my dear, that I cannot make it intelligible to you because you know nothing about optics, or the refraction of light.

Sometimes the calcspar of Iceland has a beautiful lilac tint, and here is a crystallized specimen, from Shropshire, of a pale pink colour.

Frances. These little crystals on it, are quartz, I believe.

Mrs. L. Yes calcspar occurs with a great variety of minerals; very often with fluate of lime, pyrites, sulphuret of lead, and other metallic ores. Have you remarked how distinctly the natural joints are visible in many of these crystals?

Mary. Yes; in that one, particularly, it seems as if the slightest effort would divide it parallel to the primitive rhomb.

Frances. Here is a specimen that appears to have another cleavage, perpendicular to the axis of the rhomb.

Mrs. L. That is the same kind of structure as that we observe in slate spar; it is not a true cleavage. Here are a great many more crystals, (fig. 168 to 205*,) for you to examine, but as they deserve a good deal of time and attention, suppose we leave them for another morning.

The foliated granular limestone includes a great variety of the minerals generally called marbles.

The best example of this kind of structure is the Parian marble.

Mary. I see what you mean, distinctly; it is composed of large grains, which are all separately foliated, so that the fracture is very bright.

Mrs. L. The carrara marble consists of much smaller grains, and is less translucent.

Frances. It is exactly like fine white sugar.

Mrs. L. It sometimes contains small crystals of quartz, which are called carrara diamonds; both these varieties and several others, which are quarried in Italy, Greece, and the Greek Islands, were emplyed by the ancients for the purposes of sculpture: the only one which is much used at present, is the marble of Carrara.

These limestones very rarely contain petrifactions. You have seen the fibrous limestone, I think.

Mary. Is it not called satin spar?

Mrs. L. Yes; from its silky lustre—it is sometimes turned into necklaces and other ornaments: but it is not *all* fibrous limestone that has this appearance; the fibres of some varieties are much coarser.

Frances. What is this, Mrs. L.?

Mrs. L. It is called peastone; the other side of the specimen is polished, and you may see that the little globular concretions which compose it, are concentric lamellar.

Mary. Yes; they have the same appearance as an onion when it is cut through, except being smaller.

Mrs. L. Peastone is found in large masses in the neighbourhood of the hot springs of Carlsbad in Bohemia, which contain calcareous matter. These little spherical masses each contain grains of fine sand; these are supposed to be raised by means of air bubbles in the water, and to collect round them calcareous particles, till they acquire so much weight that they fall down, and are agglutinated together. In some of them you will perceive alternate depositions of sand, and carbonate of lime. This carbonate of lime is like that contained in some of the springs of Derbyshire, which are commonly called petrifying springs.

Frances. I remember seeing a broom and a bird's nest at Matlock, which the people assured us were petrified; but I suppose they were only incrusted.

Mrs. L. Nothing more; if you were to break them, you would find the interior quite unaltered; this incrusting substance is called calc-tuff, or calcareous tufa. Some of these specimens have been formed upon moss.

Mary. I suppose it is not pure carbonate of lime.

Mrs. L. I believe it has not been analyzed; but it is most likely that it contains iron, which gives it a gray or yellowish colour; it is generally very brittle. Stalactites are produced by the deposition of carbonate of lime from water, but the process is slower than in the formation of calc tuff; so that they are frequently crystalline.

Frances. This specimen is like calcareous spar, except in its external form.

Mrs. L. They are not always pendant from the roofs of caves, but frequently incrust the sides or walls, where the water trickles down; in this way they are frequently formed in stone quarries.

Mary. But what is the reason, Mrs. L., if the carbonate of lime is once dissolved, that it should be precipitated.

Mrs. L. I was going to explain to you, my dear, that though carbonate of lime is insoluble in pure water, it is held in solution by water containing a superabundance of carbonic acid: water thus impregnated with carbonate of lime, oozes slowly through the rocks till it reaches the roof of a cave; there, before a drop is formed sufficiently large to fall by its own weight, some of the carbonic acid escapes by exposure to the air, and particles of calcareous matter adhere to the roof: every successive drop deposits particles in the same manner, till at length a stalactite is formed.

Frances. How very curious; and in this way the particles have time to arrange themselves with perfect regularity, so as to produce a foliated structure.

Mary. And some are covered with little crystals.

Mrs. L. Sometimes the percolation of the water is so rapid, that the calcareous particles are not separated till they reach the ground or floor of the cave; in this case, the concretions grow upwards, and are called stalagmites. Sometimes both kinds are formed, and the depositions increase till they meet, and thus magnificent pillars arise, which seem to support the roof of the cave. The most celebrated stalactitic cave is in the island of Antiparos, of which I dare say you have read an account.

Frances. Yes, it must be one of the most beautiful places in the world, from the description.

Mrs. L. It is a pity that it has not been examined by any mineralogist; for there is no good account of any part except that called the grotto. Stalactites were called alabaster by the ancients, who valued it very much. This is the last subspecies of limestone; the next species differs from calcspar more in composition than appearance.

Mary. Is there any particular name for it?

Mrs. L. It is called blue Vesuvian limestone; it is a *sub-carbonate* of lime; that is, it contains a smaller proportion of carbonic acid, than the other species, and eleven per cent. of water; the fracture is not perfectly foliated, but appears compact, or passing into splintery.

Frances. I suppose from the name, that it is always of this light blue colour.

Mrs. L. Yes; it is sometimes used in mosaic work to represent the sky; but a deeper blue is often required for that purpose. It has only been found in the neighbourhood of Vesuvius; it is harder than the other carbonates of lime, and the specific gravity is 2.738. The lucullite, or black marble, is of two kinds, compact and foliated.

Mary. The compact variety does not appear to be very black.

Mrs. L. Not in its natural state; but when polished, the black is very intense. If you rub two pieces together, or scrape one with a knife, you will perceive a much worse smell than that produced by the fat quartz.

Frances. Is it the same kind of smell?

Mrs. L. Yes; one variety is so extremely fetid, that it in called stinkstone or swinestone: try it.

Mary. It is very disagreeable indeed; is that owing to bitumen?

Mrs. L. I should rather think that it is caused by sulphuretted hydrogen; for bitumen is only mentioned in *one* of several analyses which I am acquainted with; but there is a kind of black limestone found in Dalmatia, which is said to be so bituminous, that it may be cut like soap; it is used there as a building stone, and when the walls of a house are finished, they set fire to them, and the bitumen, which is very inflammable, burns away.

Frances. What is the use of that?

Mrs. L. When the bitumen is destroyed, the stone remains white, for the heat is not great enough to reduce it to the state of quick lime.

Mary. That is made by burning limestone in a kiln, is it not?

Mrs. L. Yes; that process deprives it of the carbonic acid. Madreporite is another variety, named from its resemblance to the structure of madrepores: the *cross-fracture* is small and curved foliated; the smell of this kind is not so strong as the stinkstone: the specific gravity of stinkstone is 2.7.

	* Slate spar.	* Aph-rite.	* Chalk.	† Compact lime-stone.	†	‡ Calc-spar.	* Calc-sinter.	§	** Lucullite.	†† Arragonite.
Lime	55.	51.5	56.5	53.	48.	55.5	56.	58.	53.37	94.8249
Carbonic acid	41.7	39.	43.	42.5	38.	44.	43.	28.5	41.5	
Silica	—	5.7	—	1.12	7.	—	—	—	1.25	—
Alumina	—	—	—	1.	4.	—	—	1.25	1.25	—
Charcoal	—	—	—	—	—	—	—	0.25	1.25	—
Oxyde of iron . . .	—	3.3	—	0.75	2.	—	—	0.50	1.25	—
———manganese .	3.	—	—	—	—	—	—	0.28	0.75	0.0939
Carbonate of strontian .	—	—	—	—	—	—	—	—	—	4.0836
Potash and mineral acids	—	—	—	—	—	—	—	—	2.13	—
Sulphur	—	—	—	—	—	—	—	—	0.25	—
Water	—	1.	0.5	1.63	1.	0.5	1.	11.	—	0.9831
Loss	0.3	—	—	—	—	—	—	0.25	—	.0145

* Bucholz. † Simon. ‡ Philips. § Blue Vesuvian limestone.—Klaproth.
** John. †† Stromeyer.

Frances. Are not these white shining crystals calc-spar?

Mrs. L. No; they are Arragonite, so called from having been first discovered in Arragon. For some time it was called *hard carbonate of lime*, as it is harder than the other species, but their real difference was not known; it has since been found to contain 3 or 4 per cent. of the carbonate of strontian, which produces a very material alteration in its crystallization: the primitive form is an elongated octahedron (fig. 206,) one angle at the base is 115°, 56′, so that the hexagonal prisms formed by an aggregation of three of them, are not regular; three of the angles are more obtuse than the three others. You will see this better by looking on the end of one of these crystals, (fig. 207.)

Mary. That is really very remarkable: but is not this a regular hexagonal prism?

Mrs. L. No; it is formed by the aggregation of several modified rhombic prisms; and in this large one, which is of the same kind, you may see that the base has a radiated appearance; and you will find that the other faces have a slight re-entering angle parallel to the lateral edges (fig. 208;) but the prettiest crystals are these formed by the aggregation of four (fig. 209 and 210.)

Frances. They are very small; but beautifully perfect.

Mrs. L. Transparent crystals are not common. But very lately some have been found at Kosel in Bohemia, from two to three inches in length, perfectly transparent and well crystallized. One of the most beautiful varieties has been named flos ferri.*

Mary. How exceedingly delicate that is.

Frances. It is more like a beautiful white coraline than any thing else.

Mary. It appears to be covered with minute crystals, and some parts are transparent.

Mrs. L. Some of the terminations of the shoots, if I may so call them, are very perfectly crystallized.

Frances. Where are these found, Mrs. L.?

Mrs. L. In the iron mines of Stiria and Carinthia.

* I. E. flower of iron.

There is a white variety of arragonite found at Torquay in Devonshire, which very much resembles fibrous zeolite: the specific gravity is generally about 2.9. We now come to the second division of this family; it comprehends minerals composed of carbonate of lime, and a large portion of carbonate of magnesia.

Mary. I suppose, then, that the crystals are very unlike those of carbonate of lime.

Mrs. L. No; it is a curious circumstance, that the angles of the primitive rhomboid of dolomite differ from those of carbonate of lime, only in one degree and ten minutes. The obtuse edges measure 186° 15′.

Frances. Without a goniometer, the crystallization would not assist me in distinguishing it from carbonate of lime.

Mrs. L. No; but the effect of the acids is the most simple method by which you can discover whether the carbonate of lime contains magnesia. Dolomite effervesces very feebly.—Here are some very large, and nearly transparent crystals from Traversella in Piedmont.

Mary. These are much larger than any of your primitive crystals of calcspar.

Mrs. L. In general the primitive rhombs of calcspar are small.

Frances. This one is modified.

Mrs. L. It is, I think, a remarkable circumstance, that dolomite should present so little diversity of crystalline form. I have never observed above this one modification of the primitive tending to produce an acute rhomboid; while calcspar exhibits above 50.

There are other varieties of it. One, called common dolomite, is very much like the carrara marble, but of a looser texture, so that it is easily crumbled. It generally occurs with ores of metals. Compact dolomite, or magnesian limestone, is the most abundant. These specimens are from Nottinghamshire and Leicestershire.

Mary. It is very much like the common limestone: is it used for the same purposes?

Mrs. L. Yes; and the lime obtained from it is considered the best for making mortar, because it absorbs carbonic acid from the atmosphere much more slowly than

pure lime. Near Sunderland there is a kind of compact dolomite, which is flexible. This thin piece is particularly so.

Frances. It appears to me more surprizing, than the flexible sandstone, because it is so much more compact.

Mrs. L. I forgot to tell you that the foliated dolomite is sometimes called bitter spar; and a greenish variety is called miemite, from Miemo in Tuscany, where it was discovered. The next species is named gurhofian, or gurhofite, from Gurhof, in Austria, the only place where it is found.

Mary. How very compact it is.

Frances. I have seen something like it, but I cannot remember what it is.

Mrs. L. It is very much like semi-opal, but it is always white, and only translucent on the edges. Pearlspar is the most common of these species: it is not a very abundant mineral, but is met with in a great variety of situations. In most of these specimens you will see lead ore, copper pyrites, quartz, and calcareous spar.

Mary. How strangely the crystals appear to be twisted. (fig. 211.)

Mrs. L. Yes; that is very characteristic of pearl spar.

Frances. I suppose it would be difficult to measure the angles of them accurately.

Mrs. L. The result could not be depended upon, but it is most probable that the angles are the same as those of dolomite; it is generally either yellowish white, or brown, with a strong pearly lustre.

Mary. It seems to have incrusted these large crystals completely.

Mrs. L. Yes; they are cubes of fluor. The pearl spar appears very glistening, because you see the edges of a multitude of small crystals: it is harder than calcspar, but scratched by dolomite. Fibrous pearl spar is a less common variety; it appears like divergent tufts of delicate acicular crystals, or else forming small botryoidal masses, which, when broken, exhibit a fibrous structure. The specific gravity of pearl spar is 2.88: upon the whole, these minerals are distinguished from the simple carbonates of

lime by their greater hardness and specific gravity, and their very weak effervescence with acids.*

Frances. And what is this earthy substance, Mrs. L.?

Mrs. L. It is earthy marl. It is very variable in its appearance, being a mixture partly chemical, and partly mechanical, of carbonate of lime, alumina, and sand.

Mary. It is something like loam, but feels softer.

Mrs. L. The indurated marl has a very different aspect; it is compact, like some of the common clays.

Frances. Will it effervesce with acid?

Mrs. L. Yes, very readily; a property which at once distinguishes it from clay. It is found in roundish masses, and sometimes a number of small globes are aggregated together. Very often these masses are intersected by numerous fissures which are partly, and sometimes completely, filled up with calcareous spar. I have one cut and polished.

Mary. What a beautiful dark brown!

Frances. The white veins of calcareous spar running through it, have a very pleasing effect. Is it ever used as marble?

Mrs. L. Not this kind, which is called septarium; but the Florence and Cottam marbles are varieties of indurated marl. In these, the prevailing colour is a sort of cream yellow, and the landscapes and ruins which it exhibits, appear as if drawn with bistre.

Mary. I recollect some pieces in the British Museum. One represents arches and broken walls, and figures.

*	* Common	* Foliated	† Compact	* Gurhofite.	‡ Pearl spar.
		Dolomite.			
Carbonate of lime	52.	68.	55.8	70.	49.19
——— of magnesia	48.	25.5	40.8	30.	44.39
Oxyde of iron	0.2	1.	0.36	—	3.4
——— manganese	—	—	—	—	1.5
Clay, Water, &c.	—	4.	2.	—	—
Water	—	—	—	—	0.13
Loss	—	1.5	—	—	1.39

* Klaproth. † Thomson. ‡ Hisinger.

Mrs. L. It is a pity that the figures have been added: it might lead one to suppose that the other delineations were artificial. It is from the brown part of the septaria that the substance called Parker's cement is manufactured. Another variety, containing bitumen, and having a slaty structure, is called bituminous marl slate: it is always nearly black, and often contains petrifactions of fishes.

The family of phosphates of lime contains but two species, apatite and phosphorite.

Frances. Are they very different from each other?

Mrs. L. In appearance they are, but not in composition; apatite is generally crystallized, and strongly translucent, or transparent: but phosphorite is alwas amorphous and opake.

Mary. I should have thought these were crystallized beryls, the form and colour are exactly the same. (fig. 212.)

Mrs. L. They are. It resembles several minerals so strongly, that before it was analyzed, it was confounded with them by many mineralogists; and, on this account, Werner gave it the name of apatite, which is derived from the Greek word απαταω (apatāo) to deceive. Some of it is of a lilac colour, and very much like fluor, but the fracture is generally conchoidal.

Frances. These little crystals appear to be perfectly colourless and transparent. (fig. 213.)

Mrs. L. There is an extremely fine crystal of this form (fig. 215) in the British Museum, above an inch in diameter. Some green and blueish varieties are called moroxite, and the pale yellow green, asparagus stone: it is harder than calcspar, but phosphorite is rather soft.

Mary. I never saw any fracture like this.

Mrs. L. It is said to have a floriform appearance, and it is the most distinctive character of it; indeed it is not a very well marked substance. It is only found at present in Estramadura, and at Shlackenwald in Bohemia.* An earthy kind of phosphorite is found in Hun-

* See table, page 188.

gary, of a very loose texture; both kinds phosphoresce when laid on hot coals. This property seems to be common to a great many of the combinations of lime. Some of the carbonates and nearly all the fluates possess it. One variety of fluate of lime is called chlorophane, from the brilliant green light it emits when heated. Here is a piece of it, which I will put in the fire.

Frances. Its appearance is by no means beautiful at present.

Mrs. L. It requires a little time to become sufficiently hot: it is generally of a purplish brown colour; and the cleavage is not so distinct as in the common foliated fluor, or fluor spar.

Mary. See! it is becoming green rapidly.

Frances. And now it is quite brilliant like an emerald.

Mrs. L. This experiment may be repeated very often without injuring the chlorophane, if you do not heat it too much. The crystallizations of fluor are beautiful and various; some of them very complex, particularly in the specimens from the lead mines of Beeralston. (Figs. 222. 223.)

Mary. I remember seeing a great deal of fluor in Derbyshire; but this is not the kind that is turned into vases and candlesticks, is it?

Mrs. L. No; you will see some of that kind presently. I wish you to look at these crystals. (Fig. 220.)

Mary. They are cubes with the edges bevelled.

Frances. Then the cube is the primitive?

Mrs. L. That appears probable at the first glance; but the cleavage gives a very different form. Perhaps you can form an idea of it from observing some of these crystals which have been fractured.

Frances. I see that the cleavage is not parallel to the planes of a cube.

Mrs. L. No; it is parallel to the faces of an octahe-

	Lime.	Phosphoric acid.	Carbonic acid.	Muriatic acid.	Fluoric acid.	Silica.	Oxyde of iron.
* Apatite . .	55.	45.	—	—	—	—	—
* Apatite . .	53.75	46.25	—	—	—	—	—
† Phosphorite	59.	34.	1.	0.5	2.5	0.5	1.

* Klaproth. † Pelletier.

dron:—here is one (fig. 216,) and this (fig. 218,) is a figure intermediate between the octahedron and dodecahedron: but the cube and some forms which appear easily derived from it, are the most common.

Mary. It is very strange that in so many substances, the primitive should so seldom occur. Where are these dark purple crystals found? (Fig. 221.)

Mrs. L. In the tin and copper mines of Cornwall; and great quantities of pale green fluor are found there: it is used as a flux in smelting the copper ores. This is the first use to which fluor was applied; and its name is derived from flux or fluss, of the Germans. It is not often colourless: and light blue and pink are uncommon colours. Rose-coloured octahedrons are found in the mountain St. Gothard. You will not find it difficult to distinguish it from other minerals; its crystallization is generally very perfect, and its cleavage so easily obtained, that the natural joints are almost always visible when the crystals are transparent.

Frances. What metal is this with the fluor?

Mrs. L. It is sulphuret of lead. Fluor is very often found in lead mines. The kind which is used for ornamental purposes, has a course fibrous, or columnar structure, like amethyst, and occurs in large concretions in the limestone rocks of Derbyshire. In its natural state it is of different shades of blue, gray, or topaz yellow. The rich deep purple tints of these specimens are produced by heating the blue varieties, which the miners called Blue John.

Mary. I think it is one of the most beautiful minerals we have seen.

Mrs. L. Observe what a number of different substances are found with it.

Frances. Yes, in this specimen there are crystals of quartz, pearl spar, carbonate of lime, and lead ore.

Mrs. L. And the fluor of Cornwall is accompanied by mica, topazes, apatite quartz, and oxyde of tin. Compact fluor is by no means common: it is a good deal like some other minerals, particularly compact felspar, but is much softer. Very nearly all the acidiferous minerals may be scratched with a knife.

Mary. Will any besides the carbonates effervesce with acids?

Mrs. L. No; but fluor possesses a remarkable property which is peculiar to it.

Frances. What is that?

Mrs. L. The fluoric acid, which is one of its constituents, is the only one which has the power of acting on glass: it is like carbonic acid, aëriform; and if it be disengaged by means of another acid, (as sulphuric, or nitric,) a piece of glass exposed to the gas will presently be corroded.

Mary. I have heard of etching on glass: is it done by means of fluoric acid?

Mrs. L. Yes; a varnish is thinly spread over the glass on which the pattern is drawn that is intended to be corroded; and it is placed over a shallow vessel containing pounded fluor and sulphuric acid. Wherever the varnish remains the glass is unaltered; but where it is removed, it has the appearance of ground glass. I dare say you have seen panes of glass ornamented in this way.

Frances. I never thought of it before, but I think our staircase windows are patterned in this manner.

Mrs. L. Most probably they are. There is still another variety of fluor; it is in a loose earthy state, and generally of a gray or purple colour.

Mary. The purple appears very dull beside the crystallized fluor.

Mrs. L. Sometimes it is so dark as to appear nearly black.* Compact and foliated fluor are harder than apatite, and scratch carbonate of lime readily; but the *sulphates* of lime are mostly very soft. There are two kinds of sulphate of lime, or gypsum: the one contains water, the other does not, and is called anhydrous gypsum, or anhydrite: this kind is harder than carbonate of lime. There are several varieties of both these minerals.

Frances. What are these transparent crystallized specimens?

Mrs. L. They are foliated hydrous gypsum, or selenite;

	Lime.	Fluoric acid.
* Fluor spar	67.34	32.66

Thomson.

it has but one distinct cleavage; and in that direction it may be split with great ease. I will give you a slice of this large piece.

Mary. How beautifully transparent and colourless it is!

Frances. It is very much like stilbite.

Mrs. L. Yes, it has the same pearly lustre; particularly in some specimens where the folia are curved; but it is not perceptible in these small crystals. (Fig 225.) The primitive is a right prism, and its bases parallelograms. (Fig. 224.) It is said that selenite was much used for windows before the invention of glass.

Mary. I should have thought mica would answer better.

Mrs. L. Perhaps it would; but there are few places where mica is found of a sufficient size: and in France, Spain, and other parts of the south of Europe, selenite is very abundant, and easily obtained. The Romans imported it from the island of Cyprus, Spain, and even Africa, and lighted their green houses with it. Foliated granular gypsum has the same relation to selenite that marble has to calcspar.

Frances. This appears very similar to the Parian marble.

Mrs. L. Yes; but it is so soft, that it is not very fit for making statues. Vases, and other ornamental articles, are made of it. The Romans are believed to have lighted their temples by means of lamps placed in vases of gypsum; for it is sometimes strongly translucent.*

Mary. Are these gray and yellowish pieces of the same kind?

Mrs. L. Yes; and it is very frequently of a brick-red colour, which is occasioned by an intermixture of iron ochre.

*	Lime.	Suphuric acid.	Water.	Loss.
* Compact Gypsum	34.	48.	18.	—
† Foliated granular	32.	30.	38.	—
‡ Sparry, or Selenite	33.9	43.9	21.	2.1

* Gerhard. † Kirwan. Bucholz.

Frances. Is not this satin spar, Mrs. L.?

Mrs. L. No, my dear; it is fibrous gypsum; but when cut, or turned, it is very often sold for satin spar. The fibres, or rather thin columns of which it is composed, are in general, remarkably straight and parallel; but in satin spar they are frequently waved.

Mary. Besides, satin spar is harder, and effervesces with acids, which, you said, sulphates of lime would not do.

Mrs. L. And it is heavier: the specific gravity of the gypsum is about 2.2. or 2.3. The earthy gypsum is generally yellowish, and very friable: but the compact kind is about as hard as the other subspecies. It is not found in England: but there are many quarries of the granular gypsum in Nottinghamshire and Derbyshire. It is principally used as a manure for particular soils, and to make plaster of Paris.

Frances. How is plaster of Paris prepared?

Mrs. L. The gypsum is burnt in order to deprive it of the water it contains, and it becomes a white powder. In this state it has a strong affinity to water, so that when they are mixed, they very soon unite, and form a substance which resembles gypsum in composition, though not in texture.

Mary. I am much obliged to you for this explanation, for I have often made casts of medals and seals with plaster of Paris, and could not imagine what became of the water. I had no idea till lately that it could become solid without being frozen.

Mrs. L. The varieties of anhydrite are nearly the same as of gypsum; the foliated has been also called muriacite by some mineralogists, because it sometimes contains a very minute portion of common salt, which is a muriate of soda.* The crystallization is very different from that of selenite; the primitive is a square prism (fig. 227,) which sometimes exhibits several modifications, but they are rather scarce. The cleavage, which is threefold, is in general distinct.

Frances. This is very transparent and bright.

Mrs. L. It is most commonly of a very pale flesh-red, and sometimes though rarely, pale yellow, violet, and

* See table, page 193.

gray: the other varieties are generally blueish white, or white. It is considerably heavier than selenite; the specific gravity varies from 2.85. to 3. The siliciferus anhydrite is only found at Vulpino, in Italy, and thence called Vulpinite; but, in Italy, it is known by the name of marmo bardiglio di Bergamo, and Comte de Bournon has given it the name of bardiglione. The sulphates of lime are very abundant; but the other combinations of lime are scarce, and present very few varieties. Besides these minerals, two others are arranged in this family, which contain other constituents as well as sulphate of lime. Glauberite, which is a very scarce substance, is found crystallized in the form of a very oblique prism (fig. 228,) resembling an acute rhomb, and imbedded in rock-salt at Villaruba, in New Castile.

Mary. What is it composed of, besides sulphuric acid and lime?

Mrs. L. It contains 51 per cent. of sulphate of soda, which is commonly known by the name of Glauber salt; and the sulphate of lime it contains is anhydrous:—its hardness is rather greater than that of gypsum.

Frances. Is this fibrous mineral another belonging to the family of sulphates?

Mrs. L. Yes; it was formerly described as fibrous an-

*	* Compact Anhydrite.	* Radiated Anhydrite.	† Vulpinite.
Lime	42.	42.	92.
Sulphuric Acid	56.50	57.	
Silica	——	0.5	8.
Muriate of soda	0.25	——	——
Oxyde of iron	——	0.10	——
Loss	1.28	——	——

Glauberite‡	
Anhydrous sulphate of lime	49
Anhydrous sulphate of soda	51
	100

* Klaproth. † Vauquelin. ‡ Brogniart.

hydrite, but the late analyses of Stromeyer having proved that it is a combination of several salts, he has named it polyhallite.* It is found at Ischel, in Upper Austria, in the strata of rock-salt; its brick-red colour is no doubt occasioned by oxyde of iron, intermixed, but not chemically combined with it. Perhaps this is the cause of its translucency not being very great.

Mary. Is it ever crystallized?

Mrs. L. No crystals have yet been discovered, but it is not impossible they may exist: it is a little harder than carbonate of lime but is scratched by fluor, and is brittle. Combined with silica and boracic acid, lime forms datholite and botryolite; the principal difference between them seems to be that the datholite is crystallized, and the botryolite, as its name implies, occurs in small botryoidal masses, which have an earthy fracture, or when rather larger, splintery and imperfectly fibrous.

Mary. How could I distinguish the datholite from some other minerals that are like it.

Mrs. L. When it is crystallized, you would not find it difficult. There are some good crystals on this specimen. (figs. 229, 230.) It does not effervesce, and you may distinguish it from white felspar, or adularia, by its softness; it may be scratched by a knife, though it is a good deal harder than other calcareous minerals. In general, the crystals are rather dull, externally, but the fracture appears vitreous; the specific gravity is 2.98.

Frances. Is not this another specimen of datholite?

Mrs. L. No; that is tungstate of lime; it is a little like datholite, but the specific gravity is 5.5 or 6. It is lime united with tungstic acid.

Mary. I see this is crystallized in octahedrons.

Mrs. L. Yes; but they are not *regular* octahedrons;

* Polyhallite.

Dry sulphate of lime	22.36
Hydrous sulphate of lime	28.74
Dry sulphate of magnesia	20.11
Sulphate of potash	27.40
Muriate of soda	0.19
Oxyde of iron	0.32

* Stromeyer.

this one (fig. 233,) is the most common, but the primitive is more acute. (fig. 231.) It does not melt when exposed to the action of the blowpipe, but crackles and becomes opake. Arseniate of lime, also called pharmacolite, occurs in very small globular concretions, which consist of minute acicular crystals, disposed in a radiated manner; they are disseminated over this specimen of granite.

Frances. Is the pink colour of them produced by the arsenic?

Mrs. L. It is owing to arseniate of cobalt, but it is merely the surface that is tinged; internally, the colour is nearly snow-white. Silicate of lime, is called tabular or table spar; I believe, because it splits into tabular fragments.

Mary. I think you said the white shining substance along with the cinnamon stone, was table spar.

Mrs. L. Yes; but in general, it is of a greenish or grayish colour, and has a crystalline structure, exhibiting indications of a twofold cleavage; it is about as hard as datholite, and translucent.

Frances. Are these garnets imbedded in the table spar.

Mrs. L. Yes; they are generally found together in the only known locality of table-spar, (except Ceylon,) Dognatska in the Bannat of Temeswar.

Mary. Are any of the other combinations of lime found in England, besides the carbonates, sulphates and fluates?

Mrs. L. Yes; the phosphate of lime occurs in Cornwall, in the tin veins of St. Michael's Mount, and at Stenna Gwyn; and in granite at Calderbeck, in Cumberland; and tungstate of lime has been found in a tin vein of Pengelly Croft mine in Cornwall. Datholite is at present only found near Arendahl, and near Sonthofen, in Norway.

Frances. The next genus, I believe, contains the acidiferous *aluminous* minerals.

Mrs. L. Yes; except lime, alumina is found combined with a greater number of acids than any of the earths. The first family contains two different combinations of alumina, with sulphuric acid; are called subsulphates. Alum is a sulphate—you have seen it in the form of a white efflorescence, on alum slate; it occurs more rarely, massive, with a fibrous structure; its solubility and taste

distinguish it from every thing it resembles in appearances.

Mary. Here is something like porcelain earth, is it another kind of alum?

Mrs. L. No, that is aluminite, a subsulphate of alumina; it is very much like porcelain earth, but is so compact that it does not soil the fingers, but feels something like steatite; and if you powder a little, and throw it into a glass of water, you will find it will not diffuse itself through it like porcelain earth, but sinks to the bottom immediately. Alumstone, is another variety, found principally at Tolfa near Rome, where there is a hill of it: the Roman alum, which is considered the best, is prepared from it.

Frances. It appears to be harder than aluminite.

Mrs. L. Yes, it is considerably harder, and tastes very much like the native alum. For making alum, it is first broken up, and exposed to the heat for twelve or fourteen hours in a sort of kiln, which is technically called roasting it; this operation is generally repeated, that all the pieces may be equally calcined; it is afterwards placed on a sloping floor, in parallel ridges, between which there are trenches filled with water, and the alumstone is frequently sprinked, till it cracks and falls to powder; the next operation, is boiling it with a sufficient quantity of water, stirring it all the time. At the end of twenty-four hours, the fire is extinguished, and the liquor left at rest, for the undissolved part to subside; when this has taken place, the

	* Datholite.	* Botryolite.	* Tungstate of lime.	†	* Arseniate of lime.	* Silicate of lime.
Lime	35.5	13.5	17.60	19.400	25.	45.
Silica . . .	36.5	36.	3.	—	—	50.
Boracic acid .	24.	39.5	—	—	—	—
Tungstic acid .	—	—	77.75	80.417	—	—
Arsenic acid .	—	—	—	—	50.54	—
Water . . .	4.	6.5	—	—	24.46	5.
Oxyde of iron .	Trace.	1.	—	—	—	—
Loss	—	3.5	1.65	0.83	—	—

* Klaproth. † Berzelius.

clear liquor is suffered to run through a wooden spout into square wooden reservoirs, where it crystallizes.

Frances. What is the form of the crystals?

Mrs. L. The regular octahedron, generally with the angles truncated, and sometimes the edges. You might make very pretty specimens for your mantle-piece, by putting pieces of coke, or any other mineral not too compact, into a very strong solution of alum; the crystals will be abundantly deposited on them in groupes, and have a very brilliant appearance. The phosphate of alumina is called wavellite, after Dr. Wavell of Devonshire; it is disseminated over the quartz and slate of these specimens, in little spheres about the size of peas, or rather larger.

Mary. How very round they are.

Frances. Some of them are broken, and show the radiated structure; I remember your mentioning it as a very good example of that.

Mrs. L. You may see the terminations of the crystals on the exterior of some of these, which produces their crincled appearance.

Mary. I see them: but the crystals are more perfect in these little tufts. (Fig. 234.)

Mrs. L. The colour of the surface is generally ochry-brown; but internally, the wavellite of Devonshire and Cornwall is grayish white, and in small splinters, transparent: the green variety and the black, which is nearly opake, are found in Ireland.

Frances. It is a beautiful mineral. What are these deep blue crystals.

Mrs. L. They are azurite, a substance very rarely crystallized; it generally occurs in small irregular masses, imbedded in quartz—it was arranged with lapis lazuli before the composition of it was ascertained; but the colour is very different.

Mary. It is not nearly so beautiful, and this is transparent.

Mrs. L. It is a combination of phosphate of alumina and phosphate of magnesia, and the colour may, perhaps, be caused by phosphate of iron, which is always blue. Cryolite is a fluate of alumina; there are two varieties, both from Greenland.

Frances. How beautifully white this one is; does it ever crystallize?

Mrs L. I believe not; but it is lamellar, and may be cleaved into right angled parallelopipeds. Its most distinctive characters are, that it melts like ice, by simple exposure to the flame of a candle, before it can become red hot; and its translucency is increased by immersion in water.

Mary. Those experiments are easily tried, and very curious. Is it found any where besides in Greenland?

Mrs L. No, not at present. It is rather remarkable that the white cryolite is never intermixed with any other substance, but the brown contains galena, iron pyrites, carbonate of iron, quartz and felspar. The little amber-coloured crystals and fragments, imbedded in this piece of bituminized wood, are mellate of alumina, or mellite. (Fig. 235, 236.)

Frances. How could I know they are not amber if I were to find any?

Mrs. L. Amber never crystallizes, and when it is burnt emits a pleasant smell, and becomes black and shining; but mellite acquires the colour and texture of chalk: all these minerals, except the alum-stone, are very rare.

Mary. Is not this aluminite too, Mrs. L.?

Mrs. L. No, it is carbonate of magnesia: its efferverscence with acids, though slow, is sufficient to distinguish it: this kind is about as hard as calc spar, and is found in small quantity in several parts of the continent: the variety found in India, is in the state of a white powder or small roundish lumps; it contains 28 per cent. of carbonate of lime. Meerschaum is a far more plentiful species of carbonate of magnesia. In Turkey, it is very abundant particularly in Natolia, where six or seven hundred men are employed in digging it.

Frances. What use do they make of it? It is so very light, I should not suppose it would be a good building stone.

Mrs. L. No, it is used to make the boles of tobacco-pipes: its lightness arises from its being extremely porous—some of it will float on water.*

When it is first taken from the ground it is very soft,

* Meerschaum signifies sea-foam. The French call it Ecume de mer.

	Alumstone.*	Alumstone.†	Aluminite.‡	Wavellite.§	Azure stone.§	Cryolite.†	Mellite.†
Silica	24.	56.5	—	—	2.10	—	—
Alumina	43.92	19.0	29.868	37.20	35.73	23.5	16.
Magnesia	—	—	—	—	9.34	—	—
Soda	—	—	—	—	—	36.	—
Potash	3.08	4.0	—	—	—	—	—
Sulphuric acid	25.	16.5	23.37	—	—	—	—
Phosphoric acid	—	—	—	35.12	41.81	—	—
Mellitic acid	—	—	—	—	—	—	46.
Fluoric acid and water .	—	—	—	—	—	40.5	—
Oxyde of iron	—	—	—	—	2.64	—	—
Water	4.	3.	46.762	28.	6.06	—	38.
Loss	—	1.	—	—	2.32	—	—

* Vauquelin. † Klaproth. ‡ Stromeyer. § Fuchs.

and froths like soap on being mixed with water, so that it is used for washing linen. For making pipes, it is first mixed with water in large reservoirs, and, after being agitated, is left at rest for some time: a kind of fermentation takes place, and a very unpleasant smell is exhaled; as soon as this ceases, it is repeatedly washed in order to purify it, and when partly dried, is pressed into moulds, which are afterwards hollowed out: the boles, in this state, are first dried in the shade, and afterwards baked in a furnace—the yellow and brownish tints on the surface of them, are communicated by boiling them in oil and wax.

Mary. In its natural state it is something like rock-cork, except being whiter.

Frances. What is this efflorescence on this specimen, Mrs. L?

Mrs. L. It is sulphate of magnesia: it is more commonly known by the name of Epsom salt, because it was first discovered in the water at Epsom, which contains it in solution. Massive Epsom salt has been found lately in New South Wales. You know its disagreeable bitter taste, I dare say.

Mary. Oh, yes. Here are some of those curious electrical crystals (figs 237 and 238.) you showed us once before.

Mrs. L. Yes. They are borate of magnesia or *bora-

	* Carbonate of magnesia	† Meerschaum.	‡ Sulphate of magnesia	§ Borate of magnesia.	‖
Magnesia	48.	17.25	—	13.50	16.6
Silica	—	50.50	—	2.	—
Lime	—	0.50	—	11.	—
Alumina	—	—	—	1.	—
Carbonic acid	52.	5.	—	—	—
Boracic acid	—	—	—	68.	83.4
Water	—	25.	50.	—	—
Sulphate of magnesia	—	—	48.6	—	—
Sulphate of soda	—	—	1.4	—	—
Oxyde of iron	—	—	—	0.75	—
Loss	—	1.75	—	3.75	—

* Bucholz. † Klaproth. ‡ Thomson.
§ Westrumb. ‖ Vauquelin.

cite. I have some almost transparent and colourless, but, in general, they are nearly opake, and of a light dirty gray. I have never seen a cube less modified than this. (Fig. 236.)

Frances. All these crystals are detached: are they ever imbedded in any thing else?

Mrs. L. Yes, they are found imbedded in gypsum at Luneberg, in Hanover, and near Kiel, in Holstein; the only two places where it has been found: the specific gravity is about 2.9; it is sufficiently hard to scratch glass, which is a rare circumstance in the saline minerals. Silicate of magnesia is an opake, white mineral, with a very fine earthy fracture, and is called lenzinite. The minerals of the next genus are characterized by their great specific gravity.

Mary. This is uncommonly heavy, indeed.

Frances. I think you said the specific gravity of barytes was above 4.

Mrs. L. Yes; that is carbonate of barytes or witherite; its specific gravity is 4.2 or 4.3. It is not often crystallized.

Mary. This appears to have the form of quartz. (Fig. 240.)

Mrs. L. Yes; some of the crystals have a thin ochry crust, but internally they are nearly colourless, and in general strongly translucent; except the outside of the radiated masses, which sometimes exhibit pyramidal terminations. Massive witherite is very abundant in the lead mines in the north of England, and is found in several parts of the continent.*

The finest crystals I have are from Shropshire and Arkendale lead mines in Yorkshire. Sulphate of barytes exhibits a far greater variety of crystallization; and unless it is nearly opake, you may see the natural joints in most of it.

Frances. They are very distinct in this specimen: I suppose the cleavage might be easily obtained.

* Carbonate of barytes.

	Barytes.	Carbonic acid.	Water.
(Vauquelin.)	74.5	22.5	——
(Bucholz)	79.66	20.	0.33

Mrs. L. Yes; it is so brittle, that by letting it fall on the floor, you may separate it into fragments similar to the primitive, which is a right prism with rhombic bases, (fig. 242.) but more commonly the prism is so low, as to appear tabular, (fig. 243.) The crystals are so symmetrical, and the edges so sharp and perfect, that I think you will have no difficulty in understanding them.

Mary. How prettily these bluish crystals intersect each other, showing all their monifications, (fig. 243.)

Frances. Here are some, very complex, (fig. 246,) and the planes on the edges are not wider than a hair.

Mrs. L. The large wax-yellow crystals are from Cumberland, (fig. 244.) In some varieties exceedingly thin crystals are aggregated together into roundish masses, and you only see parts of their edges; they are often of a reddish colour.

Mary. Here is a magnificent crystal (fig. 247;) it must be six inches long.

Mrs. L. That is from Cumberland; it is sufficiently thick and transparent to show the double refraction. The columnar structure of these specimens arises from the aggregation of thin, imperfect prisms. The Germans call it stangenspath (stick-spar,) from the resemblance it has to a bundle of sticks. Fibrous sulphate of barytes has been found at Chaude Fontaine, near Luttich, in the Palatinate; and this dark brown variety was lately discovered at Boghasen.

Frances. The fibres diverge in the brown specimen.

Mrs L. Radiated heavy spar is a pretty variety; it is sometimes called Bolognian spar, because it was first discovered near Bologna.

Mary. Here is a complete star of crystals.

Mrs. L. This variety is remarkably phosphorescent when heated; and, after being calcined, has the property of absorbing light; so that if you expose a piece to the light for a short time, it will be visible in a dark room from the quantity of light it has absorbed, and gives out Sulphate of barytes occurs also with an imperfectly crystalline structure, like marble and compact.

Frances. This is a good deal like chalk.

Mrs. L. Yes; the miners call it cawk, it is said, from its resemblance to chalk: the specific gravity of this vari-

ety is 4.48. Some of these pieces have thin veins of sulphuret of lead running through them.

Mary. You said that a white paint was made from barytes; is it from the sulphate or carbonate?

Mrs. L. From the sulphate: the carbonate is sometimes used for poisoning rats. Hepatite is a kind of sulphate of barytes, which, when rubbed, emits a sulphureous smell:—try it.

Frances. The smell is not so strong as in stinkstone, but I think it is worse, if possible.

Mrs. L. It does not crystallize, but the structure is lamellar.*

Mary. I am afraid I shall not recollect all these varieties, but the specific gravity is an excellent distinction from other minerals.

Mrs. L. Even that may deceive you in one instance: columnar heavy spar is so much like carbonate of lead, that it may sometimes be necessary to use chemical means to distinguish them.

There is much less diversity in the strontian genus; the carbonate or strontianite is generally very pale green, and radiated or fasciculated, but rarely crystallized.

Frances. Are these acicular crystals, carbonate of strontian?

Mrs. L. Yes; they are hexagonal prisms terminated by pyramids. I do not recollect any thing that is very much

*	* Bolognese spar.	† Granular Heavy spar	‡ Columnar Heavy spar	† Hepatite.
Barytes	62.	60.	63.	85.25
Sulphuric acid		30.	33.	
Sulphate of lime	—	—	—	6.
Lime	2.	—	—	—
Strontian	—	—	3.10	—
Silica	16.	10.	—	—
Alumina	14.75	—	—	1.
Oxyde of iron	0.25	—	1.50	5.
Water.	2.	—	1.20	—
Loss, including sulphur and moisture.	—	—	—	2.25

* Afzelius. † Klaproth. ‡ Lampadius.

like it, but if you are doubtful about a specimen of this appearance, dissolve a little in nitric or muriatic acid; it will effervesce if it be *carbonate* of strontian, and a paper dipped in the solution and dried, burns with a purple flame.

Mary. That is a pretty experiment, and easily tried. Are these reddish and pale blue specimens, carbonate of strontian?

Mrs. L. No; they are sulphate: they have a good deal of resemblance to the sulphate of barytes, but the specific gravity is less, between 3.6 and 3.7. Haüy named it celestine from its beautiful light blue colour. A great deal is found in the neighbourhood of Bristol; but the finest specimens are brought from Sicily.

Frances. Is this fine groupe of transparent crystals Sicilian? (fig. 248.)

Mrs. L. Yes; and these specimens, where the little crystals are diverging from a mass of sulphur, (fig. 249.)

Mary. Then it is a volcanic production, I suppose.

Mrs. L. In *this* case it is most likely to be so, from the appearance of the sulphur and the situation in which it occurs. Some of the crystals are very brilliant.

Frances. They appear to be very much like those of the sulphate of barytes.

Mrs. L. Yes; the primitive is a prism which differs very little from that of the barytes.* It is sometimes fibrous, like carbonate of lime. Sulphate of strontian is harder than heavy spar, which will assist you in distinguishing them.† You have now seen nearly all the natural combi-

* The angles of the base of the primitive are 104° and 76°. Those of sulphate of barytes are 101°. 42, and 78°. 18.

†	* Strontianite.	†	‡ Sulphate of Strontian.	*
Strontian - - -	69.5	62.	57.64.	56.
Carbonic acid -	30.	30.	—	—
Sulphuric acid -	—	—	43.	42.
Oxyde of iron -	—	—	—	Trace.
Water - - - -	0.5	8.	—	—

* Klaproth. † Pelletier. ‡ Rose.

nations of earths with each other, and with acids. Can you tell me any properties which characterize the two classes *generally ?*

Frances. I do not recollect any description which would apply to them all.

Mary. I think one property is common to them all, except alum and Epsom salt,—insolubility.

Mrs. L. You are right; and the greater part of them have a specific gravity between 2. and 3.5. The next class comprizes the compounds of acids, and the three alkalis, potash, soda, and ammonia, which are soluble and sapid. Potash has only been found combined with nitric acid, forming nitre or saltpetre; it occurs as an efflorescence consisitng of capillary crystals or flakes, which incrusts chalk and limestone rocks.

Frances. Does it taste like common saltpetre?

Mrs. L. Yes; but it is not pure; the nitre of Molfetta contains 30 per cent. of carbonate of lime, and 25 of sulphate of lime. In France, nitre is collected from the surface of the chalk near Evreux, seven or eight times a year, and it is very abundant in several parts of the world.* Soda is never found pure, but several of its salts occur. Carbonate of soda is found in Egypt on the surface of the earth, and on the margin of some lakes, which are dry in the summer.

Mary. Is it like the soda we use for making saline draughts?

Mrs. L. No, it appears of a gray colour, and is very impure, containing muriate and sulphate of soda. It is found in several other countries; a radiated variety called trona, is found not far from Fezzan in the north of Africa, in great quantities, which is more pure; it is sent principally to Tripoli and Egypt.† Sulphate of soda is called Glauber salt. It is generally found as an efflorescence in the neighbourhood of mineral springs, and salt lakes; sometimes in acicular crystals.

Frances. What is the form of them?

* In India, Persia, and Arabia, there are large tracts covered with nitre; and the desert of Nitria or Nitron in Egypt, whence it was named, furnishes abundance of it.

† See table, page 206.

Mrs. L. Generally, imperfect prisms; but if you dissolve the pure sulphate of soda, and suffer it to crystallize, you will obtain hexagonal prisms terminated at each extremity by two planes. A species of sulphate of soda, containing a considerable portion of sulphate of magnesia, is called reussite:‡ muriate of soda is by far the most abundant of its salts.

Mary. I think you said that was common salt.

Mrs. L. Yes; but you know that, in general, it undergoes the process of refining before it is fit for use; the rock salt of most countries is intermixed with a quantity of earthy matter, which renders it opake, and gives it a brownish or reddish colour, like this from Cheshire. Sometimes, however, it is very transparent, and quite colourless, as at Cordova in Spain. Here is a crucifix carved in rock salt.

Frances. How beautifully clear! I should have taken it for glass.

Mrs. L. The salt rocks of Cordova are very remarkable; they are isolated hills, which rise immediately from an extensive plain; some of them are between 300 and 400 feet high. There is a similar hill in the province of Lahore in India; but in most countries it occurs below the surface of the earth, and is worked like other mines.

Mary. I remember to have read a description of the salt mines at Wielitzka, where it is said several subterranean

†	Carbonate of Soda.	Trona.
Dry carbonate of soda	32.6.	7.5.
Dry sulphate of soda	20.8.	2.5.
Muriate of soda	15.	—
Water	31.6.	22.5.

‡	Carb. of soda.	Sul. of soda.	Mur. of soda.	Carb. of lime.	Sul. of lime.	Mur. of magnes.	Sul. of magnes.
* Sul. of soda	6.63	67.024	11.	5.643	—	—	—
* Reussite	—	66.04	—	—	0.42	2.19	10.42

* Reusse.

chapels have been carved in the salt, all furnished with altars and crucifixes.

Mrs. L. When they are lighted up, they must have a very brilliant appearance; but I believe the beauty of the salt mines has been much exaggerated by some travellers; the salt in the lower parts of the mines is much purer than near the surface of the earth, and of course whiter and more transparent. Here is a crystallized specimen from Wielitzka.

Frances. Is the cube the primitive?

Mrs. L. Yes; the cleavage is parallel to the faces of the cubic crystals: the salt is sometimes tinged with a beautiful purplish blue, but this is not common. There are extensive salt mines at Soowar in Hungary, in Germany, Siberia, Africa, and indeed in most parts of the world, and in a very elevated part of the Andes; but those of Wielitzka, which are above 600 feet deep, are, I believe, the largest: they have been worked since the year 1251.

Mary. I had no idea that salt was so abundant.

Mrs. L. Besides the rock salt, and a great quantity that is collected from the bottoms of lakes, which are dry during several months in the year, a great deal is obtained from salt springs in England and many other countries; and it constitutes about one thirtieth part of the ocean. Nearly all the margin of the Caspian Sea, for several miles in width, is covered with salt; which it may be supposed is in consequence of its evaporation, as its level is 200 yards lower than that of the Black Sea. Borax, which is soda combined with boracic acid, is found in Thibēt and Persia, and it is said, in China and Peru. These detached greenish crystals are from Persia, (fig. 251.)

Frances. These are very perfect indeed. What sort of taste has it?

Mrs. L. Its taste is a good deal like bicarbonate of potash with a slight degree of sweetness. It possesses double refraction; but these crystals are not sufficiently transparent for you to see it. Only two salts of ammonia have been discovered in a native state; muriate of ammonia is commonly called sal-ammoniac. It is a volcanic production, generally in the state of powder enclosed in lava, but sometimes irregularly crystallized, and either white or tinged with yellow, and very soft. Sulphate of ammonia is

mostly of a yellow or yellowish gray colour, and occurs in crusts on the lava of Ætna and Vesuvius?

Mary. How could I distinguish them from each other?

Mrs. L. Dissolve a little of your specimen in water; the solution, in both cases, will be transparent, and add a drop or two of muriate of barytes, which is also soluble: if it be sal-ammoniac, no alteration will take place; but if it be sulphate of ammonia, you will immediately see a white cloud formed, and the solution will appear milky.

Frances. What is the reason of that, Mrs. L.?

Mrs. L. The barytes combines with the sulphuric acid contained in the sulphate of ammonia, and forms an *insoluble* compound, which is therefore immediately visible, and the muriatic acid, which is disengaged, unites with the ammonia. This, you see, is a very inconsiderable class, compared with the others: you will find the metals much more interesting.

CONVERSATION XII.

MRS. L.

BEFORE you look at these specimens, I must say a few words respecting their arrangement. Metals are either found in a metallic state, or combined with sulphur, with oxygen, chlorine, or some of the acids. Some of them occur in all these five states, others in only one or two of them.

Mary. Then I suppose that each metal constitutes a genus, which is subdivided into families of sulphurets, oxydes, &c.

Mrs. L. That is not exactly the case; for a few of the metals have only been found in a small proportion in the ores of others, so that we have but twenty-three genera, though there are twenty-eight metals.* In a metallic state, metals are either pure, or combined with each other, forming alloys. This is their simplest form. The combinations with chlorine, are called chlorides; and as chlorine, though formerly considered as one of the acids, differs from them in not containing oxygen, the chlorides are distinguished from the salts. This table will serve to give you a general idea of the classification.

1st Genus. (*Gold.*)
Families. Alloys.
2d. (*Platinum.*)
Families. Alloys.
3d. (*Palladium.*)
Families. Alloys.

* Exclusive of the metallic bases of the earths.

4th. (*Iridium.*)

FAMILIES. Alloys.

5th. (*Tellurium.*)

FAMILIES. Alloys.

6th. (*Mercury.*)

FAMILIES. Alloys—Sulphurets—Oxydes—Chlorides.

7th. (*Silver.*)

FAMILIES. Alloys—Sulphurets—Oxydes—Chlorides—Salts.

8th. (*Copper.*)

FAMILIES. Alloys—Sulphurets—Oxydes—Salts.

9th. (*Iron.*)

FAMILIES. (Alloys—Sulphurets—Oxydes—Salts.

10th. (*Manganese.*)

FAMILIES. Oxydes—Salts.

11th. (*Uranium.*)

FAMILIES. Oxydes.

12th. (*Cerium.*)

FAMILIES. Oxydes—Salts.

13th. (*Tantalum.*)

FAMILIES. Oxydes.

14th. (*Cobalt.*)

FAMILIES. Alloys—Sulphurets—Oxydes—Salts.

15th. (*Nickel.*)

FAMILIES. Alloys—Oxydes—Salts.

16th. (*Molybdenum.*)

FAMILIES. Sulphurets.

17th. (*Tin.*)

FAMILIES. Sulphurets—Oxydes.

18th. (*Titanium.*)

FAMILIES. Oxydes—Salts.

19th. (*Zinc.*)

FAMILIES. Sulphurets—Oxydes—Salts.

20th. (Bismuth.)

FAMILIES. Alloys—Sulphurets—Oxydes.

21st. (*Lead.*)

FAMILIES. Alloys—Sulphurets—Oxydes—Chlorides —Salts.

22d. (*Antimony.*)

FAMILIES. Alloys—Sulphurets—Oxydes.

23. (*Arsenic.*)

FAMILIES Alloys—Sulphurets—Oxydes.

Mrs. L. Some of these families only contain one species, but others, several. Some of the metals are united with oxygen in different proportions.

Frances. Is there any oxyde of iron besides that which is commonly called, rust?

Mrs. L. Yes; there are two oxydes of iron, you will see one in its natural state.

Mary. Gold, I see, is only found in a metallic state; so that there can be no difficulty in knowing it.

Mrs. L. The pure gold, or that which is very nearly so, is easily known; but I am not sure whether you would take this for an ore of gold.

Mary. Perhaps not; it has more the appearance of brass.

Mrs. L. Brass you know, is not found in a native state; this has been called brass-yellow native gold, from its colour: it contains about 21 per cent. of silver and copper. It does not occur in the form of sand or grains like the other kind, but generally in small plates and leaves, or dendritic forms.

Frances. Some of this is very pretty; it is like moss.

Mary. But gold does not crystallize?

Mrs. L. Yes; the gold on some of these specimens is an aggregation of small imperfect crystals; and they are occasionally found perfect and detached. The best I have seen, are in the gold sand found at Mattagrossa in South America. I have put some under the microscope, for the grains are too minute to be seen distinctly without a very high magnifier.

Frances. How very bright they are! here is an octahedron with the edges truncated, and a cube; the edges are not quite sharp.

Mrs L. I have drawn some of these crystals, (figs. 252,

253, 254, 255,) which may be derived from the cube of octahedron; but a great many of them I cannot make out; they seem to be six and eight sided prisms, terminated by pyramids. This is a curious macle, (fig. 257.)

Mary. What crystal is it derived from?

Mrs. L. Apparently from a cube with truncated angles, (fig. 256.) Here is a piece of selenite containing ramifications of gold. It occurs very frequently intermixed with quartz and iron pyrites, and in large rolled pieces as well as sand; both in the beds of rivers, and in mines. A mass was found in Peru in the year 1730, which weighed 45 pounds.

Frances. What an immense piece!

Mrs. L. I believe it is the largest ever found. A species containing 36 per cent. of silver, called electrum, is found at Schlangenberg in Siberia.

Frances. I did not know that gold was found any where besides, India, Africa, and South America.

Mrs. L. It is found more abundantly in those places than other parts of the world, but there are gold mines in Spain, Hungary, Transylvania, and many other parts of Europe. Gold has been found in England, in the lead hills, and the stream works of Cornwall; and at one time, at Wicklow, in large pieces; the brass coloured gold is found chiefly in Hungary and Transylvania. These are grains of platinum.

Mary. They are very much like iron.

Frances. I could not have supposed it was so heavy.

Mrs. L. The specific gravity is very great; but crude platina is not so heavy as pure gold, for it contains a small quantity of several metals.

Mary. I recollect your mentioning that: they are palladium, iridium, rhodium, and one more I believe.

Mrs. L. Osmium. In general, these angular grains contain also a minute proportion of iron, copper, and lead; the small flattish ones consist of platinum, palladium, and gold. The grains of palladium that occur intermixed with these, are very small, and have a radiated texture. There is scarcely any visible difference between the grains of iridium and those of platinum; but they are not like platinum, soluble in a mixture of nitric and muriatic acid. None of these metals occur quite pure; they are all found

in South America, between the second and sixth degree of north latitude; but the only known European locality of platinum is the silver mines of Guadalcanal in Spain.

Frances. You mentioned the other day, when speaking of platinum, that Dr. Wollaston had made platinum wire so thin that you could hardly see it, and that you would tell us how he measured its diameter. I forget what part of an inch it was.

Mrs. L. The $\frac{1}{18780}$th part—the operation was extremely simple: a hole was drilled through the centre of a thick piece of *silver* wire, into which was fixed a piece of platinum wire of the same length, which fitted the hollow: the two metals were then drawn out together in the usual manner;* and the silver was dissolved by nitric acid, which has no effect on the platinum. By knowing the orignal thickness of each wire, and of the silver one after it was reduced, it was easy to know that of the platinum one.

Mary. Yes, by proportion: but what was the use of making such thin wire? merely for the sake of experiment, I suppose.

Mrs. L. It might have been done originally with that view; but this wire is now substituted in telescopes for threads of the spider's web which were formerly employed as cross threads: they cannot be too thin for this purpose. Large quantities of platinum are consumed in the potteries: you know it is used to cover porcelain and earthenware, in imitation of silver.

Frances. Yes, and they have an advantage over silver, of not tarnishing.

Mrs. L. Well, we have said a great deal about this metal; I believe we may proceed to the next.

Frances. What is it? it has a lighter colour than the platinum, or palladium.

Mrs. L. It is native tellurium: there are four alloys of this metal, all found in Transylvania, where they are worked for the gold and silver they contain: this species contains less than the others. Crystals are very rare;

* In order to render wire thinner, it is forced through a small hole in an iron plate; this operation is repeated several times, the hole being smaller each time.

and even in this foliated granular state the metal is not plentiful. The graphic ore of tellurium contains 30 per cent. of gold and 10 of silver.

Mary. Why is it called graphic ore? Can you write with it?

Mrs. L. No; it was so named because it is usually disseminated over the earthy minerals which it accompanies, in small prismatic crystals, grouped together so as to have some resemblance to written characters.

Frances. This is much more brilliant than the native tellurium.

Mrs. L. The white or yellow ore of tellurium is also very shining: it differs from the graphic ore in containing 19 per cent. of lead, and the specific gravity is 10.6. that of the others is scarcely 8. The black tellurium ore is very different from the others.

Mary. Is this it? It is in plates something like mica.

Mrs. L. Yes, but the lustre is perfectly metallic, and it is opake; and the folia, if sufficiently thin, are flexible, but not elastic like mica. The specific gravity is very nearly 9. All the four species are soft and sectile.

Frances. But would these characters be sufficient to enable me to distinguish a specimen of tellurium from one of any other metal?

Mrs. L. Perhaps not in all cases: but some of its chemical properties are very peculiar: it melts before the blowpipe at rather a low heat, then emits a white smoke, and burns with a green flame till it is volatilized, and gives out a smell resembling horse-radish. The gold and silver which are contained in the ores, are reduced to a metallic state by the blowpipe.* Mercury is the next genus. I dare say you have never seen it in a native state. Here is a specimen covered with little globules.

Mary. That is very pretty. Some of them are larger than a pin's head.

Mrs. L. Take care not to touch them or shake them off. Mercury in this state is much more rare than the sulphuret, from which most of the quicksilver of commerce is obtained. This is very nearly pure; but it is sometimes united to silver in sufficient proportion to constitute a

* See table, page 215.

solid, or semi-fluid amalgam, which is sometimes crystallized in the form of cubes and octahedrons, having their edges and angles truncated. Here is a specimen of it crystallized; and on this it is disseminated in small flakes.

Frances. It is almost as white as silver; but the edges of the crystals are not sharp.

Mrs. L. No; they generally appear a little rounded. There are two species of sulphuret of mercury, cinnabar, and the hepatic, or liver ore.

Mary. Which is this beautiful crimson red specimen?

Mrs. L. That is cinnabar: it has generally an imperfectly crystalline structure approaching to compact, and is translucent particularly on the edges: but the crystals are sometimes nearly transparent.

Frances. There are some groups of crystals on this, but they are so small that I cannot make them out.

Mrs. L. Haüy supposed a hexagonal prism to be the primitive form, but more recent investigations have shown it to be an acute rhomboid. (fig. 258.) Cinnabar is soft, but rather brittle; and if you scratch it with a knife, or any hard substance, the streak is scarlet which distinguishes it from some other red ores. Here is another variety, called native vermilion: it is more of a scarlet colour, and earthy. If you should ever be doubtful about a specimen of cinnabar, you will find the blow-pipe useful; the sulphur burns with a blue flame as soon as it begins to melt, and the mercury is volatilized.

Mary. What is this, Mrs. L.; it looks quite glassy?

Mrs. L. That is the hepatic ore; it acquires a brown-

* ORES OF TELLURIUM.

	Native.	Graphic.	Yellow.	Foliated.
Tellurium . .	92.55	60.	44.75	32.2
Gold	0.25	30.	26 75	9.
Iron	7.20	—	—	—
Silver . . .	—	10.	8.50	0.5
Lead	—	—	19.50	54.
Copper . . .	—	—	—	1.3
Sulphur . . .	—	—	0.50	3.

* Klaproth.

ish colour by exposure to the air, but when fresh broken, it is of a dark gray, inclining to crimson. It is very brittle.

Frances. What is the difference between this and cinnabar.

Mrs. L. This species contains iron and carbon;* but it is often intermixed with cinnabar. It occurs in several quicksilver mines, but particularly those at Almaden in Spain, in Idria, and Siberia. The mines near Almaden have been worked upwards of two thousand years; and those of Deux Ponts, Idria, the Palatinate, and Spanish America, are very considerable. The chloride of mercury, which is sometimes called horn quicksilver, is semi-transparent, and nearly colourless.

Mary. Why is it called horn quicksilver?

Mrs. L. On account of its texture; it is soft, but brittle. The crystals are always very small, but in general brilliant; they are cubes, sometimes modified, and octahedrons. Before the blowpipe, it is volatilized.

Frances. Are there no more species of chloride of mercury?

Mrs. L. No; and this one is rather scarce.

The silver genus exhibits a good deal of variety; the first family contains native silver, and several alloys, but the native silver is the only one of the species which is plentiful.

Mary. Is it more common than the other ores?

*	Cinnabar. *	Cinnabar. †	Hepatic ore. †
Mercury	81.	84.50	81.80
Sulphur	15.2	14.75	13.75
Charcoal	—	—	2.30
Silica	—	—	0.65
Alumina	—	—	0.55
Iron	4.7	—	0.20
Copper	—	—	0.02
Water	—	—	0.73
Loss	—	0.75	—

* Lampadius. † Klaproth.

Mrs. L. I believe it is; it forms the greatest part of many of the richest mines, and is occasionally found in immense masses, scarcely intermixed with any of the substances that are generally found in the veins with it. The silver mines of Konigsberg, in Norway, which are the most northern in Europe, formerly afforded uncommonly large specimens, from 100 to 150 pounds in weight; and in the mine called Nye Forhaabning one was raised, weighing 560 pounds.

Frances. Those would be magnificent specimens for a museum.

Mrs. L. The last I mentioned, is still preserved in the royal collection at Copenhagen. The others were probably smelted.* Some of these specimens are tarnished by exposure to the air; but those which I have covered with a glass, preserve their original whiteness and brilliancy.

Mary. This is extremely beautiful; it appears like fern leaves composed of crystals.

Frances. Yes; and if you look at this with a glass, you will see some octahedrons.

Mrs. L. Native gold, silver, copper, and all other native metals that crystallize, take the form of the cube, octahedron, and these forms derived from them (figs. 251 to 256.) Silver is sometimes compact, or nearly so, and very often resembles the branches of fir trees, particularly that from the mines of Potosi. I think you would be very much pleased with Mr. Sowerby's "Exotic Mineralogy;" every mineral that is described in it is illustrated by a coloured engraving; it contains some very good representations of the dendritic and arborescent forms of native gold, silver, and copper, as well as of a great many other minerals. Perhaps his work on "British Mineralogy," which is executed in the same manner, would be the most useful to you; they are both very interesting works.

Mary. Here are some pieces that seem like masses of silver wire, twisted and interlaced

Mrs. L. That is not uncommon; the threads (or wires)

* It is mentioned by Albini, that at Schneeberg, in the year 1478, a rich vein was discovered, and so large a block of native silver ore cut out, that Duke Albert, of Saxony, descended into the mine and used it for a table to dine on. It smelted 44,000lbs. of silver.

are very flexible, for the silver is extremely pure: scarcely ever containing one per cent. of any other metal. I have native silver in selenite, and on purple fluor; but more commonly it is intermixed with limestone or quartz, and pyrites, ores of cobalt and arsenic. The auriferous silver ore contains nearly 30 per cent. of gold.

Frances. I suppose it is heavier than common native silver?

Mrs. L. Yes; the specific gravity is above 10.6, but that of native silver does not exceed 10.34: it is rather yellower than pure silver. This specimen is antimonial silver.

Mary. Is its gray colour owing to a tarnish?

Mrs. L. Yes; in its natural state it is nearly as white as pure silver, but it has less lustre. Before the blowpipe, the antimony evaporates in the form of a gray smoke. The arsenical and bismuthic silvers are still more rare than this; they contain very little silver, and are merely objects of curiosity. Another alloy has been lately discovered by Berzelius, to which he has given the name of Eukairite: it consists of silver, copper, and selenium.

Frances. Have you any of it?

Mrs. L. No; it is very rare. It was found at an old abandoned copper mine at Skrickerum, in Smoland; it is described as having a blue colour, and a foliated granular texture. When it is subjected to the action of the blowpipe, it melts, and exhales a strong smell of horse-radish, which is peculiar to selenium.

These minerals belong to the second family.

Mary. Are there many sulphurets of silver?

Mrs. L. We are acquainted with four species, which differ from each other, not only in the proportions of silver and sulplur, but in containing a large quantity of some other metal. The silver glance, or vitreous silver ore, as it is sometimes called, is a nearly pure sulphuret, of a blackish gray colour: its crystallizations are the same as those of native silver. Here is a beautiful group of crystals with a blue iridescence on the surface: but more commonly it is found in masses, or penetrating the earthy minerals in which it occurs, in all directions.

Frances. Does glance mean sulphuret?

Mrs. L. No; it is a word introduced from the Ger-

man school of mineralogy: it signifies something bright. But though some of this has a good deal of metallic lustre, the term *glance* is sometimes applied to minerals that have not much claim to it. The specific gravity of this is about 6.9: it is so sectile that you may cut it like lead, which distinguishes it from the antimonial sulphuret.

Mary. Is that brittle?

Mrs. L. Yes; it has been called brittle silver ore.

Frances. Can you obtain the silver from them, by means of a blowpipe?

Mrs. L. Yes; the sulphur, and the antimony which renders the second species brittle, evaporate. The cupreous sulphuret is of a dark lead colour; it has only been found at Schlangenberge, in Siberia. The white silver ore is more abundant. This piece is from Saxony.

Mary. It is not very white.

Mrs. L. It contains a great deal more lead than silver. The minerals of these two families are characterized by a metallic lustre; but this is not the case with all the remaining species. The oxyde of silver is red: and the light and dark coloured varieties are distinguished from each other, as different species.

Frances. Then their composition, I suppose is different?

Mrs. L. Yes; formerly it was believed that red silver ore was a sulphuret of silver containing arsenic or antimony; afterwards it was discovered* that the metals were in a state of oxydes. But the recent analyses made by Dr. Proust, show them to be in a metallic state. He found that there are two species, one containing arsenic, the other antimony. He has not described the specimens he analyzed; but it appears probable that the dark red silver ore contains the arsenic.†

Mary. This I suppose is the light red variety, it is semi-transparent.

Frances. All these specimens seem to consist of small crystals, some rounded and some perfect; or at least to be covered by them.

Mrs. L. Yes; it rarely occurs in masses, but it has

* By Vauquelin.

† Thompson's Chemistry, 6th edition, vol. iii. p. 453.

	* Auriferous Silver.	† Antimonial Silver.	† Arsenical Silver.	† Bismuthic Silver.	‡ Eukairite.	† Sulphuret of Silver.	§ Sulphuret of Silver.	† Antimonial sulphuret.	‖ Cupreous sulphuret.	† White silver ore.
Silver - -	72.	77.	12.75	15.	38.93	85.	84.	66.5	52.272	20.40
Gold - -	28.	—	—	—	—	—	—	—	—	—
Antimony -	—	23.	4.	—	—	—	—	10.	—	7.88
Lead - -	—	—	—	33.	—	—	—	—	—	48.06
Arsenic - -	—	—	35.	—	—	—	—	0.5	—	—
Bismuth - -	—	—	—	27.	—	—	—	—	—	—
Iron - -	—	—	42.25	4.3	—	—	—	5.	0.333	—
Copper - -	—	—	—	0.9	23.05	—	—	—	30.478	—
Selenium - -	—	—	—	—	26.	—	—	—	—	—
Sulphur - -	—	—	—	16.3	—	15.	16.	12.	15.782	12.25
Silica - -	—	—	—	—	—	—	—	1.	—	0.25
Alumina - -	—	—	—	—	8.9	—	—	—	—	7.
Loss - -	—	—	4.	3.5	3.12	—	—	5.	1.135	1.91

* Fordyce. † Klaproth. ‡ Berzelius. § Sage. ‖ Stromeyer.

sometimes a deutritic or moss-like appearance. The crystals of dark red silver ore are exactly similar to these, and much larger.

Mary. Here are some very perfect hexagonal prisms; are they primitive crystals?

Mrs. L. No, my dear; the primitive form is a rhomboid, rather more obtuse than that of carbonate of lime; and many of the crystallizations of the two substances are very similar (figs. 260, 261, 262, 263.)

Frances. Most of them, I think; here is a termination like the equi-axe (fig. 263.)

Mary. And here is a metatastic dodecahedron, (fig. 262.) with some other modifications on it: but Mrs. L., these are very nearly black and opake, and the lustre almost metallic.

Mrs. L. The colour is very deep; but a small fragment is strongly translucent, and the colour a bright blood red, like the other kind. This ore melts before the blowpipe, and sometimes the sulphur it contains, burns away with a blue flame.

Frances. Is it common?

Mrs. L. Yes, it is rather abundant in the mines of Germany and Mexico.

Mary. I believe there is a chloride of silver too?

Mrs. L. Yes; it is a little like the chloride of mercury, but occurs in much larger masses and crystals.

Frances. This is a very large cube, it appears nearly transparent internally: does it acquire this thin gray crust by keeping?

Mrs. L. Sometimes it is found coated in this way. It is so soft that you may stick a pin into it: you may try the experiment on this little greenish specimen.

Mary. It feels like sticking it into wax.

Mrs. L. It is very splendent, where it has been broken or scratched: but in some parts it appears earthy, as if it might be easily crumbled.

Frances. It is a very curious mineral; what is the specific gravity of it?

Mrs. L. It is about 4.8. The only natural salt of silver at present known, is a carbonate containing antimony; it is gray, soft and shining, and effervesces with nitric acid:

it is found only in a mine at Altwolfatch, in the Black Forest. You will find in the examination of metallic minerals, that the blowpipe is extremely useful; the results are in general so well characterized, and so easily obtained.

Mary. I wish, Mrs. L., you would have the goodness to give us some little scraps of the minerals we have seen, to examine chemically. I should like to try how well I recollect what you have told us of them.

Mrs. L. I will do that willingly; and as you cannot yet be very expert in using the blowpipe, I would recommend you to use charcoal as a support for them; it is particularly useful in the reduction of oxydes, because it absorbs the oxygen, and assists in decomposing them. The next genus will afford you a good opportunity of exercising your chemical knowledge.

Frances. Is there a greater variety of copper ores than of silver ores?

Mrs. L. Yes; there are several sulphurets, and a great many salts; the native copper is found unalloyed, except with a trace of iron and gold.*

Mary. Some of these specimens are very bright, there could be no difficulty in knowing them to be copper.

Mrs. L. They are chiefly from Cornwall, Siberia, and Saxony. Some of the crystals are good, but they do not occur very frequently. It is most commonly found in masses, which have a confused and imperfect crystallization, with large interstices, or in irregular plates; here is one of that kind, partly coated with red oxyde of copper.

Frances. This has none of the lustre or colour of pure copper; how would you know it

Mrs. L. By the weight and degree of flexibility, and by scratching it, which would show the hardness, colour, and lustre.

Mary. What is the green part of this specimen?

Mrs. L. It is probably carbonate of copper, but it is most frequently intermixed with the red oxyde, or dispersed through quartz or carbonate of lime. The purest sulphuret of copper, is called copper glance, and some of it

* According to the analysis of Dr. John; the specimen was from Ekaterineburg.

is very brilliant; but the finest and largest crystals are mostly dull and blackish.

Frances. These are double pyramids I believe, (fig. 265.)

Mrs. L. Yes; the primitive is a hexagonal prism (fig. 264.;) but it seldom occurs without modifications (fig. 266.)

Mary. The little bright crystals are mostly very thin, and look as if they would split.

Mrs. L. Scarcely any of it will yield to cleavage, except an uncrystallized variety with a foliated structure, the fracture of this is uneven or small conchoidal.

Frances. Then I should suppose this to be the same substance, not crystallized.

Mrs. L. You are right; it often occurs massive, both in Cornwall and Germany, and in other parts of the world.

Mary. How very strange it appears, that a mixture of sulphur and copper should be of this deep gray colour. These things seem to me a great deal more curious than the compounds of the earths, though perhaps they are not so in reality.

Mrs. L. It is because you are so much more accustomed to see many earthy minerals in almost a natural state; such as marbles, serpentine, agates, and precious stones, without thinking of how many substances they are composed; but the metals which you see in common use, are mostly simple substances derived from natural combinations, with which you are scarcely acquainted; these sulphurets are sectile, and the specific gravity is about 5. or 5.4. The second species is the variegated copper ore.

Frances. What beautiful colours! would you not call this iridescent?

Mrs. L. Yes; some parts exhibit all the colours of the rainbow.

Mary. But they do not seem to be the original colour of it.

Mrs. L. No; they are a tarnish acquired by exposure to the air; the original colour is a little browner than copper; copper pyrites frequently exhibits the same appearance.

Frances. I suppose it must be a very abundant mineral, I have seen it with many others.

Mrs. L. Yes; it is by far the most common ore of copper, and occurs in a variety of forms; but usually, massive or crystallized; the primitive form is the rhomboidal dodecahedron; but this has been discovered from its cleavage very lately; it was thought to be a tetrahedron.

Mary. How curiously the faces of these crystals are curved, (fig. 272.)

Mrs. L. That is the result of a modification nearly similar to this (fig. 269.;) the crystals are often found covered with a thin blackish or gray coating; the colour of the fracture is generally brass yellow.

Frances. Is this pyrites too, Mrs. L.? it has a botryoidal form.

Mrs. L. Yes; the colour is deeper, and the fracture duller, and more compact than in the crystallized pyrites; these crystals on quartz, (fig. 270, 271.) are intermixed with crystals of copper glance.

Mary. What is the difference between this and the variegated copper ore?

Mrs. L. Copper pyrites contains more iron and sulphur in proportion to the copper, than the other species; sometimes above 40 per cent. of iron; they are both soft enough to be scratched with a knife, which is a good distinction between copper and iron pyrites; for they are much alike, and often occur together. White copper ore, which is the rarest in this family, resembles copper pyrites, except in colour.

Frances. What are these crystals, Mrs. L? not white copper I should think (fig. 270.)

Mrs. L. No; they are gray copper ore; the crystallizations are the same as those of pyrites, but it differs in composition; it contains much less sulphur, and some arsenic.

Mary. I suppose then that the blowpipe would distinguish it from the gray crystals of copper pyrites?

Mrs. L. Yes; it gives a white smoke; you must not expose them to a great heat at first, because they crackle very much. Tennantite* seems to differ from gray copper

* Discovered by Mr. Phillips in some Cornish copper mines near Redruth.

	* Copper-glance.	† Copper-glance.	‡ Variegated copper ore.	§ Copper pyrites.	‖ Gray copper ore.	** Tennantite.	†† Black copper ore.	†† Black copper ore.
Copper	78.5	61.62	58.	41.0	42.5	45.32	39.	40.25
Iron	2.25	12.75	18.	17.1	27.5	9 26	7.5	13.5
Arsenic	—	—	—	—	15.6	11.84	—	0.75
Antimony . . .	—	—	—	—	1.5	—	19.5	23.
Silver	—	—	—	—	0.9	—	—	0.3
Sulphur . . .	18.5	21.65	19.	45.1	10.	28.74	26.	18.5
Oxygen . . .	—	—	5.	—	—	—	—	—
Mercury . . .	—	—	—	—	—	—	6.25	—
Silica	0.75	—	—	—	—	—	—	—
Earthy matter . .	—	3.50	—	—	—	5.00	—	—
Loss	—	0.47	—	—	2.0	—	1.75	3.7

* Klaproth. † Brandes. ‡ Klaproth. § Lampadius. ‖ Klaproth. ** Phillips. †† Klaproth.

ore, in containing more sulphur, and is harder. Black copper ore is the black oxyde which generally occurs as a thin earthy crust, coating other ores.

Frances. I think you once mentioned another oxyde of copper, which crystallized in a great variety of forms.

Mrs. L. Yes : the red oxyde, or ruby copper ore : I have a great many specimens of it, chiefly for the sake of the crystallizations they exhibit : some of the crystals are semi-transparent.

Mary. The light coloured varieties are very much like red silver ore.

Mrs. L. Yes, in colour ; but the crystals are generally more perfect than in light red silver ore. The primitive form is the regular octahedron : but it cannot be easily obtained by cleavage. It would be useless for you to examine all the little crystals that I have detached, at present. Mr. Phillips has enumerated about a hundred varieties produced by the combinations of nine modifications.

Frances. That is a great number, indeed ; but as the modifications are so much fewer than in carbonate of lime, I should think the derivation of the crystals from the primitive would be more easily traced.

Mrs. L. Yes ; you may generally recognize some of the faces of the octahedron, though it is often distorted by the extension of some of the planes. I believe all these forms occur in Cornwall (Fig. 273 to 281.) The crystals are generally very small, particularly the complex ones, except the detached ones found at Chessy in France. They are all coated, like these, with green carbonate of copper.

Mary. I do not see any macled crystals.

Mrs. L. No ; it is possible that they exist, but I have never observed any. The most beautiful variety is the *capillary* red copper ore : the colour is brilliant carmine red, and on this account it has been called contains copper ore ; the cavities in this specimen are filled with it ; you see the thin square prisms generally intersect at right angles ; but sometimes they form divergent tufts. The beautiful crimson colour you have seen in stained glass is occasioned by oxyde of copper ; formerly, it was thought that it could only be produced by gold. The third species, containing a good deal of red oxyde of iron, is called tile ore, from

its appearance and colour; it is nearly infusible before the blowpipe, and the proportion of copper it contains varies from ten to fifty per cent.

Among the salts of copper, the family of carbonates perhaps offers the greatest variety; the malachite you admired so much is one of the species.

Mary. It is a beautiful mineral, I should like to see some that is not cut and polished.

Mrs. L. Well, here are a great many specimens, fibrous, earthy, and compact.

Frances. I suppose this is compact.

Mrs. L. Yes; if it were cut, it would have the same appearance as that you saw in the Museum; the external form is botryoidal, and the structure concentric lamillar; so that when it is cut, it appears marked with concentric rings, or parts of circles, alternately light and dark. Here is a piece where the surface appears almost entirely composed of hemispheres, and the concretions are so distinct, that they appear to be a collection of little cups, fitting into each other.

Mary. That is a beautiful example of the structure.

Frances. This specimen seems to have been formed like a stalactite; though it consists of concentric shells.

Mrs. L. Yes; and if you examine the fracture, you will see that it is very delicate fibrous; the fibres diverging from the centres of the concretions; in the massive malachite this fracture passes into chonchoidal, but there is scarcely any lustre except in the fibrous malachite.

Mary. Are these beautiful little tufts of a dark bright green colour, fibrous malachite?

Mrs. L. Yes; they are delicate capillary crystals, which are sometimes aggregated into small masses in the manner of zeolite; the lustre of them is very silky.

Frances. But are the crystals never larger than these?

Mrs. L. Yes; here is a group where they are from half an inch to an inch in length, but they are extremely scarce: these are from Saxony; but the finest specimens of compact malachite are brought from Siberia: most of that found in the Cornish mines is very pale and earthy sometimes incrusting the massive red oxyde.

Mary. What are these blue crystals, Mrs. L.?

Mrs. L. They are blue carbonate of copper; some varieties are very beautiful.

Frances. The crystals seem to be similar to those of malachite.

Mrs. L. It is conjectured that the crystals of malachite have once been blue carbonate of copper, as they differ very little in composition; the malachite contains the greatest proportion of water. The rhombic prisms, nearly similar to obtuse rhombs, which are found at Chessy, are considered to be primitive crystals, though it may be cleaved in three other directions; the dark ones have a rich purple tint, but the light coloured varieties are nearly pure blue.

Mary. I recollect admiring very much a large specimen in the Museum, called velvet copper ore, of a brilliant light blue colour.

Mrs. L. It is only found at Oravicsa in the Bannat, forming a velvety crust on malachite and brown iron-stone; its name is very characteristic; it is arranged as a distinct species at present, for it has not yet been analyzed. The finest specimens of indurated blue copper ore are from Chessy and Siberia. Some of these crystals are semi-transparent and very brilliant; the larger ones are only faintly translucent on the edges; sometimes they are aggregated into little balls and irregular roundish forms.

Frances. But does it never occur compact like malachite?

Mrs. L. It is sometimes massive, but the texture is nearly earthy, and it is not sufficiently hard to be used for any ornamental purpose, like malachite; all the carbonates are sufficiently soft to be scratched with a knife, and their specific gravity is about 3.5, except the anhydrous carbonate, which is much lighter; its specific gravity is 2.62, it is of a blackish brown colour, and opake, generally containing quartz crystals, and a mixture of other copper ores. It was discovered in India some years ago.

Mary. What is this, Mrs. L.? the green is bluer, and less pleasing than in the other specimens.

Mrs. L. It is chrysocoll;* a species containing less

* Sometimes called Copper green, or Mountain Green.

carbonic acid than the others—it differs too in some other external characters from the compact malachite, and has a shining vitreous lustre. The dark dull green which is intermixed with it is called iron-shot copper green. Chrysocoll effervesces with acids much more slowly than the other carbonates.

Frances. Will the blowpipe reduce it to copper?

Mrs. L. Not without the addition of borax or some other flux: while melting, it tinges the flame, green: most of the copper ores will give a green colour to the flux before they are reduced.

There are two species of silicate of copper—these little fragments are called dioptase.

Mary. Do not you think they might easily be mistaken for emeralds?

Mrs. L. Yes, at first sight, particularly as the crystal is a hexagonal prism, but the terminations (which are very seldom perfect) are the summits of a rhomb which is the primitive, (fig. 286.) and it is scarcely hard enough to scratch glass; it has been called emerald copper ore: the other species is a carbonate combined with silica, which I have not seen. The next family contains the arseniates of copper; which, except the species containing iron, are found only in Cornwall.

Mary. Are there many species?

Mrs. L. It is generally divided into four or five, but there may be more varieties. The principal kinds are the lenticular, the hexahedral or foliated, the trihedral, and the fibrous. The lenticular arseniate occurs in very flat octahedrons having a square base, and is blue, or bluish green. But Mr. Brooke, who has lately spent much time in investigating the crystallizations of arseniate of copper, is of opinion, that the primitive form is a very oblique rhombic prism, (fig, 288.)

Frances. These appear to be very perfect, and they are translucent.

Mary. Is this the foliated kind? it is greener than the lenticular arseniate.

Mrs. L. Yes; it is sometimes called copper mica—it consists of small thin plates, which are sections of an acute rhomb. (fig. 289.)

Frances. Are they not hexagonal plates?

U

Mrs. L. Yes; but the lateral planes (or edges) are trapeziums, which incline alternately contrary ways—and if you divide an acute rhomb, which Mr. Brooke has shown to be the primary form of this variety, by planes perpendicular to its axis, you will obtain similar plates, (fig. 290.)

This will scratch gypsum, but not calcspar. The dark olive green crystals on those specimens are a variety of the trihedral arseniate, or oliven ore, a name it received from its colour.

Mary. I cannot distinguish the form of them—they seem to be the summits of crystals arranged in radiated tufts.

Mrs. L. You are right; where the tufts are broken, you may see the radiated structure—the single crystals are represented by this model, (fig. 292,) the primitive crystal is a right rhombic prism. (fig. 291.) Another variety of oliven ore occurs in the form of irregular octahedrons, derived from an oblique rhombic prism, (figs. 293, 294,)—very often they are nearly black, and very brilliant—but if you scratch them, you will find the streak of a straw colour.

Frances. If these minerals are exposed to the blowpipe, will the arsenic acid evaporate in a white smoke?

Mrs. L. There will be scarcely any smoke, but you will perceive a smell of garlic, which is peculiar to arsenic. They melt at first into a black, porous scoria; and if you continue to melt this, with the addition of borax, you will obtain a bead of copper. The fibrous arseniate is perhaps merely a variety of the oliven ore, deprived of the water of crystallization; the fibres are very delicate, and it approaches to a fine earthy texture—all the species are found with quartz; generally filling the spaces between the crystals.

Mary. Are the crystals on this specimen, oliven ore too? (fig. 295.)

Mrs. L. No; they are called martial arseniate—they contain iron, and are always light blue.

This is rather an unimportant family, as no use is made of any of the species.

Frances. Are they never worked as copper ores?

Mrs. L. No; they are found in too small a quantity;

	* Blue carbonate.	* Malachite.	* Mountain green.	† Silicate.	‡ Copper mica.	‡ Lenticular arseniate.	* Oliven ore.	‡ Martial arseniate.	§ Muriate.	* Phosphate.
Oxyde of Copper	70.	70.5	50.	55.	58.	50.	50.62	22.5	70.5	68.13
Oxyde of Iron . .	—	—	—	—	—	—	—	27.5	—	—
Carbonic acid . .	19.	18.	7.	—	—	—	—	—	—	—
Arsenic acid . . .	—	—	—	—	21.	14.3	45.	33.5	—	—
Muriatic acid . .	—	—	—	—	—	—	—	—	11.4	—
Phosphoric acid .	—	—	—	—	—	—	—	—	—	30.95
Silica	—	—	26.	33.	—	—	—	3.	—	—
Water	2.	6.	17.	12.	21.	35.7	3.5	12.	18.1	—
Loss	2.	—	—	—	—	—	0.88	1.5	—	0.92

* Klaproth. † Lowitz. ‡ Chenevix. § Proust.

and to separate the arsenic acid, would be a difficult and tedious operation.—These specimens are muriate of copper it was first discovered in Peru, in the form of a brilliant green sand, intermixed with small quartz crystals.

Mary. It is very much like dioptase in colour and translucency, how could I distinguish them ?

Mrs. L. Muriate of copper is soluble, both in nitric and muriatic acid; the dioptase in neither—besides, their crystallization is very different (fig. 296, 297.)

The small shining octahedrons scattered over this piece of quartz, are phosphate of copper.

Frances. They are very similar to something I have seen before, pleonaste I think.

Mrs. L. They are a good deal alike, but these are *rectangular* octahedrons—the fracture is diverging fibrous. Sulphate of copper is a soluble salt, which I dare say you have seen ; it is commonly called blue vitriol.

Mary. Yes, I have ; it is a fine blue inclining to purple, and the crystals rather flat.

Mrs. L. The natural crystals are small and rarely perfect ; it occurs intermixed with copper pyrites and earthy matter ; sometimes in masses. You have now seen nearly all the copper ores ; some of them are very abundant, but the greater number are found sparingly.

Frances. There is a great deal of variety in their appearance, but I cannot help thinking that I should know most of them if I were to see them again.

Mrs. L. Most of the species are well marked, and where the external characters are variable, you will find the chemical ones very satisfactory. To-morrow, you will see the iron ores.

CONVERSATION XIII.

MARY.

AMONG the ores of iron, is there any native iron?

Mrs. L. Yes; but it is scarce, compared with many of its combinations, such as pyrites and the red oxyde; there are two kinds of native iron, terrestrial, and meteoric; that is, iron which has fallen through the atmosphere.

Frances. I have often heard of showers of stones, but never could learn where they came from.

Mrs. L. The original situation of meteoric stones has been frequently discussed; but I believe without their appearance being satisfactorily accounted for. It has been supposed by some, that they are formed in the air, from particles that are constantly floating in it. However this may be, there is no reason to doubt of their aerial descent, as several masses, both of stones and iron, have been seen to fall in different parts of the world; and judging from the similarity of their appearance and composition, the masses of native iron found in the desert of Sahra, in Siberia, Mexico, and South America, are supposed to have had the same origin.

Mary. Then I suppose this is not quite pure iron?

Mrs. L. No; it is a remarkable fact, that all the meteoric iron contains a quantity of nickel from 3.5 to 10 per cent.; but it is not sufficient to alter its appearance or malleability; and you see this piece has become slightly oxydated, like other iron.

Frances. Has meteoric iron always this cellular or corrodeol appearance?

Mrs. L. No; that appearance is nearly peculiar to the

native iron of Siberia; the exterior of the mass at the Cape of Good Hope is quite smooth, and for a long time was called an old anchor by persons who had no knowledge of its real nature: when the Emperor of Russia was in England, Mr. Sowerby presented to him a small sword made of it. It occurs in many parts of the world:* the Esquimaux discovered by Captain Ross in his arctic expedition had knives made of iron, which contained 3.5 per cent. of nickel; and from the description of the appearance and situation of the original blocks, they are considered to be meteoric. Terrestrial native iron is far more rare; small pieces have been occasionally found in the scoria of extinct volcanoes.

There are two species of sulphuret of iron, or pyrites; this kind is magnetic.

Mary. Will it attract needles as a magnet does?

Mrs. L. No; but it will attract the polar magnet. It is generally of this reddish or bronze yellow colour; and massive, or imbedded in limestone, quartz or mica-slate, with other minerals, and ores of iron: it is sometimes crystallized in hexagonal prisms and pyramids.

Frances. Will not these bright yellow crystals attract the magnet.

Mrs. L. No; they are common pyrites, which contains much more sulphur than the first species; this is divided into several subspecies: but Comte Bournon is of opinion, that analysis will some day prove that there are at least two (if not more) species united under the name of cubic pyrites; because, after examining the cleavage of a great many crystals, he found the primitive to be sometimes a cube, and sometimes an octahedron.

Mary. The faces of all these cubes, I see, are streaked in a particular direction, (fig. 301.)

Mrs. L. All these crystals (figs. 302, 303, 304,) are derived from the striated cube; those streaks (fig. 301.) are parallel to the edges of the pentagonal dodecahedron, which are situated over the planes of the cube. Here are cubes, of which the faces are quite smooth, and probably

* A tract of land many leagues in extent, thickly strewed with large masses of meteoric iron, has lately been discovered in South America by M. Aimé Bompland.

the octahedron is the primitive form. The most brilliant pyrites is that found in Peru; the early inhabitants appear to have made mirrors of it; in consequence of which it was named Piedra de los Incas:* the other varieties are cellular and capillary, which are rather scarce, and radiated pyrites, which occurs more abundantly in small stalactitic and botryoidal masses. I dare say you may have seen them on the sea-shore, where the cliffs are of clay or chalk, as they are originally imbedded in them; they are sometimes called thunder-bolts.

Frances. Yes; I think I have seen some, but I forget where.

Mrs. L. Very likely in the Isle of Wight; but they occur in Derbyshire and many other places.

Mary. Most of these have a dark brown crust. Is that difference from the yellow radiated part?

Mrs. L. Yes, it is produced by the action of the atmosphere, which decomposes the pyrites so much, that the iron it contains, becomes oxydated—that is in fact, rust of iron. The specific gravity of iron pyrites varies very little; it is generally 4.7, but it is a mineral so well characterized, that you will hardly find it necessary to refer to that property, to distinguish it; it will give sparks with steel in the manner of flint. The first species of oxyde of iron is the magnetic iron-stone.

Frances. I suppose this is the *black* oxyde. I recollect you told me there were two kinds, black and red.

Mrs. L. Yes, but this is a chemical compound of the two oxydes; it is most commonly granular, or approaching to compact: but sometimes it occurs in octahedrons and rhomboidal dodecahedrons, which are in general, small and grayish black. I have put some needles on one of the specimens, and if you lift it up, you will find that they adhere very firmly.

Mary. Yes they do; this then is not only magnetic, but has polarity.†

Mrs. L. Yes; but it is very singular, that it has not this property till some time after it is taken from its original situation, or unless it lies near the surface of the

* Iron pyrytes is often called marcasite by the miners.

† See page 63.

earth. There are very extensive mines of it in Sweden, particularly at Danemora; where the bed which is worked, is several hundred feet thick; it is very abundant too, in Saxony.

Frances. Is it never found in England?

Mrs. L. Small quantities have been met with in Cornwall and Devonshire, but it is not considered of importance as an English iron ore.

Mary. How beautiful *these* specimens are—look at those brilliant colours—are they magnetic iron ore?

Mrs. L. No, they are called specular iron ore, or iron glance from their lustre; those beautiful colours are not essential to the substance, but are a superficial tarnish, like that on tempered steel; internally, the colour is steel gray. The finest specimens are found in the Isle of Elba, where it is more plentiful than any where else; the mines there have been worked about 3000 years.

Frances. It has very much the appearance of steel, is it hard?

Mrs. L. Yes, and rather tough, but you can scratch it with a knife, and the streak appears of a deep blood-red colour: the variety called iron-mica occurs in splendent hexagonal plates, so thin, that by holding them in the sunshine, you will find they are semi-transparent.

Mary. Yes, they are a fine deep red colour: the plates are streaked in three directions parallel to the sides of the hexagon.

Mrs. L. The primitive form is an acute rhomboid differing very little from a cube: the crystals of Elba iron glance are seldom very perfect, and therefore difficult to make out (figs. 305, 306, 307;) they are derived from the same primitive.

	* Native Iron.	*	† Iron pyrites.	† Magnetic pyrites.
Iron - - - -	96.5	96.75	47.5	63.5
Nickel - - -	3.5	3.25	—	—
Sulphur - - -	—	—	52.5	36.5

* Klaproth. † Hatchett.

Frances. Can the iron be separated from the oxygen in these ores, by the blowpipe?

Mrs. L. No; the process for obtaining iron from them, is much more tedious than that used with some other iron ores. The titaneous iron ore, which is compact, and of a colour inclining to reddish brown, is found in Sweden and Norway, it affects the magnet very slightly; it is oxyde of iron containing titanium.

Mary. Are there any more black iron ores?

Mrs. L. No; these are varieties of the red oxyde: three of them, the scaly, the compact, and the fibrous, are so nearly pure oxyde* of iron, that the other constituents cannot be considered essential to them, or of any importance, but the red ochre is very impure; containing a great proportion of clay.

Frances. I suppose this is the ochre; it looks like clay, strongly coloured by iron.

Mary. Is this red oxyde of iron? the colour is extremely deep.

Mrs. L. Yes, it is the compact kind, the colour approaches to gray; but the fibrous variety is frequently blood-red: this is generally called hæmatite.

Frances. The structure of this is similar to that of malachite, except that in some of these specimens the fibres are so very long.

Mrs. L. But there is very seldom any appearance of concentric lamellar formation in hæmatite.

The burnishers used in the Birmingham manufactories for polishing gilt buttons are made of hæmatite. The scaly red iron-stone† is the least abundant; it consists of fine scaly particles with a faint lustre which soil strongly: the other kinds are the most abundant of the English iron ores.‡ This dark brown shining mineral is called stilpnosiderite: it is a subspecies of the hydrate of iron.

Mary. How very resinous the lustre is: it is a good deal like pitchstone, except in being opake.

Mrs. L. And the specific gravity is nearly 3.8: it is

* Peroxyde; signifying that which contains the greatest proportion of oxygen; the black oxyde is called protoxide.

† Or red iron froth.

‡ All the Lancashire and Leicestershire iron ores are of this kind.

hard, but a knife will scratch it, and the streak is yellowish brown: it is found in Father Abraham's mine at Schiebenberg, in Saxony.

Frances This specimen is exactly like hæmatite except in colour.

Mrs. L. It is called brown hæmatite, but the fibres are never long, as they sometimes are in the red hæmatite. The compact and fibrous brown iron-stone sometimes occur in pseudo crystals, but they are rare. This, which is the ochry* hydrate, is found in great plenty in England.

Mary. Is it not yellow ochre?

Mrs. L. Yes; it is very extensively used in house-painting, to make stone colours, and olive greens, and for colouring white-wash. The globular hydrate is distinguished into lenticular, kidney form, and pisiform (or pea ironstone) according to its external shape. The last variety consists of roundish grains aggregated together.

Frances. Some of them are broken; and the colour is yellower, and lighter within.

Mrs. L. In the centre of the kidney form masses, (which vary from the size of a walnut to several inches in diameter)—there is frequently a quantity of ochre; and they are always more compact at the surface, than in the interior. The bog-iron ore is supposed to be constantly formed, by deposition from water containing oxyde of iron, in morassy grounds. According to its degree of hardness, it is called meadow ore, swamp ore, and morass ore.

Mary. What is this piece; it is compact and shining in the middle, but on both surfaces it has the appearance of moss.

Mrs. L. That is meadow ore. It is generally almost black, where it is compact, but yellow and brown on the dentritic parts. Sometimes the compact and ochry parts are in alternate plates, and very often these ores contain vegetable substances. The morass ore is quite friable, and earthy.

Frances. Is this another variety of it?

Mrs. L. No; that is umber; a hydrate of iron and

* Ochry brown iron-stone.

	* Iron mica.	† Iron froth.	‡ Red hæmatite.	§ Stilpnosiderite.	‖ Brown hæmatite.	‖ Compact brown ironstone.	‖ Lenticular hydrate.	‖ Iron ochre.	‖ Meadow ore.	** Umber.
Peroxyde of iron . .	94.38	94.5	90.	80.5	82.	84.	73.	83.	61.	48.
Oxyde of manganese	—	—	Trace.	Trace.	2.	1.	1.	Trace.	7.	20.
Silica	—	4.25	2.	2.25	1.	2.	9.	5.	6.	13.
Alumina	—	1.25	—	—	Trace.	—	—	—	2.	5.
Lime	—	—	1.	—	—	—	—	—	—	—
Phosphate of lime .	2.75	—	—	—	—	—	—	—	—	—
Magnesia	0.16	—	—	—	—	—	—	—	—	—
Stony matter . . .	1.25	—	—	—	—	—	—	—	—	—
Water	—	—	3.	16.0	14.	11.	14.	12.	19.	14.
Loss	1.46	—	4.	—	1.	2.	3.	—	5.	—

‡ Hisinger. † Henry. * D'Aubuisson. § Ullmann. ‖ D'Aubuisson. ** Klaproth.

manganese; you know it is prepared for painting, both with oil and water.

Mary. Yes; is it found in England?

Mrs. L. No; it is brought from the island of Cyprus. The next are the salts of iron, which are rather numerous.

Frances. These specimens are not so beautiful as the salts of copper.

Mrs. L. There are few minerals which present such a variety of brilliant colours as the copper ores. The colours produced by iron, and which are characteristic of its ores, are generally dark or dull; prussian blue, however, is a preparation of iron; it does not occur in a natural state. The carbonate of iron is mostly of a light yellowish brown; sometimes dark and reddish, and very much resembles carbonate of lime: their primitive forms differ only in a few degrees.* This is from Cornwall.

Mary. I suppose it will effervesce too?

Mrs. L. Yes; but its specific gravity, which is about 3.6, is sufficient to distinguish it from carbonate of lime, and before the blowpipe it becomes black. There is still another method of determining whether a specimen be a carbonate of lime, or of iron.

Frances. What is that?

Mrs. L. I am going to show you. I have put a very small quantity into this wine glass, and I add to it nitric acid. You see it is rapidly dissolving with effervescence; but as this effect would take place with any other carbonate in the same situation, I shall add a little prussiate of potash, as soon as the effervescence has ceased. Look.

Mary. The liquid has become bright blue.

Frances. And the colour is deepening. What is the reason of it?

Mrs. L. The prussic acid, which was combined with the potash, unites to the iron, and forms prussiate of iron, or prussian blue.

Mary. That is a very pretty experiment; I think, when I am uncertain about a carbonate of iron, I will try it.

Mrs. L. The variety in hexagonal prisms, was disco-

* The angles of incidence of the planes, are 107 and 73.

vered not long ago in Cornwall: a more common form is the equiaxe rhomb. It is harder than carbonate of lime.

Frances. The prisms have very much the colour and lustre of wax. And some of this is like pearl spar.

Mrs. L. Yes, it is. I have also a fibrous variety. Clay iron ore is an intimate mixture of carbonate of iron with silica and alumina. It varies considerably in its appearance. A good deal of it resembles clay stone; and sometimes it has the forms of shells and reeds.

Mary. Is this crimson mineral, clay ironstone.

Mrs. L. Yes; that is the jaspery kind; it contains more silica, and is harder and more shining than the others. The phosphate of iron is blue. Those crystals are from Cornwall, (fig 308.)

Frances. How very transparent they are.

Mrs. L. There is sometimes a slight degree of pearliness in them; the primitive form, deduced from its cleavage, is an oblique parallelopiped, very nearly like that of euclase; it may be cleaved readily in one direction, parallel to the axis.

Mary. And is this phosphate of iron? it looks like the compact blue copper ore.

Mrs. L. Yes, that is the earthy phosphate; the composition is the same as that of the crystals, but it looks almost like a lump of indigo. It acquires that deep colour by exposure to the air; when it is first taken from the beds in which it occurs, it is grayish white.

Frances. Is it found in England?

Mrs. L. No; it was discovered in the neighbourhood of Schneeberg, but has since been found in North America, Brazil, and the Isle of France. It is very soft

Mary. And what are these small green cubic crystals?

Mrs. L. They are arseniate of iron.

Frances. Some of them appear to be modified by small planes.

Mary. Yes, and like the borate of magnesia, only the alternate angles are truncated, (figs. 309, 310, 311.)

Mrs. L. That circumstance suggested to me that it might possess the property of becoming electric by heat, and a few days ago I tried the experiment.

Frances. And was it electric?

Mrs. L. Yes, rather strongly. Some of the brightest and largest crystals are very translucent; but they are not common; indeed it is rather a scarce substance; it has been found in the Cornish mines, Carrarach, Muttrell, and some others; and at St. Leonard, in the department of Haute Vienne, in France; the specific gravity is 3. Pitchy iron ore, a combination of arseniate and sulphate of iron, which is found in Saxony, is very scarce; it is semitransparent, of a brown colour, and occurs incrusting other minerals; it is very brittle, and soft. There is another species called skorodite, which is considered to be an arseniate of iron and manganese.

Frances. Is this it, Mrs. L.?

Mrs. L. No, I have no specimen of it; that is chromate of iron; it is quite opake, and has a more metallic lustre than most of the salts of iron; it is sufficiently hard to scratch glass; and sometimes crystallizes in octahedrons.

Mary. I think, without a magnet, I might mistake it for magnetic iron ore.

Mrs. L. You may distinguish it by melting a little with potash and dissolving it in water; the solution will be of a beautiful orange colour. There are three substances at present known which may be arranged under the next species, silicate of iron,—the first is a silicate containing water, named from Hedenberg, who first analyzed it, hedenbergite. Yenite, or lièvrite, is better known; it is a silicate of iron and lime, which is found in the Isle of Elba.

Frances. This appears to be a very fine specimen—the crystals are so perfect, (fig. 312) Is the substance from which they radiate, also yenite.

Mrs. L. Yes, it is compact yenite; four sides of the prisms are longitudinally streaked, and where there are more, they are smooth. It is said that the colour sometimes becomes lighter and brownish by exposure to the air, and that when first procured it is *always* black.

Mary. Are these silicates very hard?

Mrs. L. No; the yenite will scratch glass, but not felspar. Pyrosmalite,* a silicate of iron and manganese, oc-

* Or pyrodmalite.

	* Carbonate of iron.	† Carbonate of iron.	‡ Clay iron-stone.	§ Phosphate of iron.	‖ Arsen. of iron.	† Sulphur seniate.	‖ Chromate.	** Hydrous silicate	†† Yenite.	‡‡ Pyrosmalite.	‖ Tungstate.
Oxyde of iron	42.38	57.5	33.5	41.25	48.	33.46	34.7	35.25	35.	35.480	18.
Oxyde of manganese .	—	3.5	1.5	—	—	0.59	—	0.75	3.	23.444	6.25
Oxyde of chromium .	—	—	—	—	—	—	43.	—	—	—	—
Silica	3.8	—	14.3	1.25	—	—	2.	40.62	28.	35 850	1.5
Alumina	—	—	22.6	5.	—	—	20.3	0 37	0.6	—	—
Lime	—	1.25	—	—	2.	—	—	3.37	12.	1.210	—
Magnesia	13.6	—	—	—	—	—	—	—	—	—	—
Carbonic acid	43.22	36.	28.1	—	—	—	—	1 59	—	—	—
Phosphoric acid . . .	—	—	—	19.25	—	—	—	—	—	—	—
Arsenic acid	—	—	—	—	18.	26.06	—	—	—	—	—
Sulphuric acid	—	—	—	—	—	10.75	—	—	—	—	—
Muriatic acid	—	—	—	—	—	—	—	—	—	2.905	—
Tungstic acid	—	—	—	—	—	—	—	—	—	—	67.
Water	—	—	—	31.25	32.	28.48	—	16.05	—	—	—

* Drappier. † Klaproth. ‡ Richter. § Laugier. ‖ Vauquelin.
** Hedenberg. †† Descotils. ‡‡ Hisinger.

curs in short hexagonal prisms of a liver-brown colour, which emit a strong smell of chlorine when heated by the blowpipe.

Frances. What does it smell like.

Mrs. L. Sea-weed. Tungstate of iron is much more abundant than either of these—it is well marked by its very dark brown colour, and the brilliance and decision of its cleavages.

Frances. They are very distinct, but I see no appearance of external crystallization.

Mrs. L. Crystals of wolfram (as it is sometimes called) are scarce. They are parallelopipeds, sometimes modified on the edges and angles, (fig. 313.) It is generlly in masses, or penetrating quartz and copper ore; it occurs in most tin mines; there is a great deal in the neighbourhood of the abandoned mines at Cligga, in Cornwall, but it is of no use. It has a very peculiar glisten, which I think you will not forget; and it has a great deal of resemblance to brown bleade; but its specific gravity is much higher, being rather above seven, and the streak of a reddsh colour. I am sorry I cannot show you a good specimen of the sulphate of iron, but it is only found in small quantities among pyrites; all that is used in commerce, is prepared artificially.

Mary. How is that done?

Mrs. L. The pyrites, from which it is obtained, is first exposed to heat for some time, which is called roasting it, and then laid in large heaps under sheds. These heaps are frequently moistened, and the sulphur, uniting with the oxygen of the water and the air, becomes sulphuric acid, dissolves the iron, and is suffered to run into large reservoirs, and afterwards boiled. The natural sulphate arises from a decomposition of the pyrites amongst which it is found.

Frances. Is not pyrites worked as an iron ore?

Mrs. L. No; but at Anglesea, there is a manufactory for sulphur, which is prepared from it; the pyrites, when broken up, is roasted or burnt; this occasions the sulphur to separate in the form of vapour; and it is collected in long flues, where it is condensed and becomes solid. The residue is of a fine deep red colour, and is used at Liver-

pool for painting ships. I believe you know that sulphate of iron is used in making ink?

Frances. Yes; I have heard it called green vitriol.

Mary. Are there any more minerals belonging to this genus?

Mrs. L. No; the next are the ores of manganese, which generally contain some proportion of iron; and you will find (by the tables of analyzes) that oxyde of manganese occurs in many iron ores. Manganese has never been found native; all these specimens are varieties of oxyde; those in the next drawer, are salts.

Frances, I think I have seen some of these little dark shining crystals, before.

Mrs. L. Yes, they are frequently found in tufts on quartz; they contain a good deal of iron; but the gray oxyde of manganese occurs in a more compact state, very abundantly; the compact and fibrous varieties are like brown hæmatite in their external form; and the fibrous resembles it in fracture too; sometimes it is stalactitic.

Mary. Then how do you distinguish them?

Mrs. L. Manganese is much softer than the hydrate of iron; but the most satisfactory manner of examining it, is to melt a little with glass of borax; it will produce a reddish purple tint in it. The compact manganese is quite black.

Frances. These specimens that have a metallic lustre, I suppose are radiated.

Mrs. L. Yes, many of them are very brilliant, but few of the crystals are perfect; their prisms are so aggregated together; the primitive is a right rhomboidal prism, generally long in the radiated specimens, and terminated by two or four planes (figs. 315, 316.)

Mary. Some of these appear to have six or eight sides.

Mrs L. That is not uncommon; the primitive crystals occur principally in the foliated kind, and are generally so short as to resemble cubes, at first sight. (fig. 314.)

Frances. There appears to be a complete transition in these minerals from the compact to the foliated; in some of these the fibres are very fine, yet I should hardly know whether to call them fibrous or radiated.

Mrs. L. You may consider them as both, for the composition of all of them is nearly the same, and the terms

which distinguish the different subspecies can only be applied to those which are distinctly marked. The least common variety is earthy; it has scarcely any lustre, and soils very strongly.

Mary. I see that, by the condition of my fingers after touching it, they are quite black.

Mrs. L. Most of the gray manganese ores will leave a trace on paper; the earthy is the darkest; the black oxyde has not, I believe, been analyzed; it is much more rare than the gray ore, and is generally found with the gray ore of antimony; it is quite black and sometimes friable, or dentritic; the only variety that has any lustre, is the foliated.

Frances. I suppose it will colour borax, purple, like the other species.

Mrs. L. Yes; that is characteristic of all manganese ores. The species called wad, appears both from its composition and external characters, to be very little different from umber; but it contains more manganese than iron, and it frequently has a decided external form.

Mary. Yes; these are botryoidal and reniform, and look as if they had been imbedded in something else.

Mrs. L. That kind occurs in basalt and hornstone. This specimen, about the colour of the gray ore, is sulphuretted oxyde: when it is exposed to the action of the blowpipe, you may smell the sulphur which is disengaged; it is found at Nagyag with the ores of tellurium.

Frances. I think there is some tellurium here: what is the specific gravity of these minerals?

Mrs. L. The compact and radiated gray manganese have a specific gravity between 3.5 and 4.5; the sulphuretted oxyde is very nearly 4.

Mary. Is this one of the acidiferous compounds of manganese? it is like the oxyde.

Mrs. L. Yes; that is the phosphate; you may easily distinguish it from the oxydes, by its being readily fusible by the blowpipe, without the addition of any flux, into a black enamel; and in thin fragments, it is semi-transparent.

The prettiest ore of manganese is the silicate; it is of a rose colour of various degrees of intensity.

Frances. This is very beautiful, and I think these dark

	* Radiated Gray Manganese Ore.	†	‡ Compact gray Mangan.	‡ Sulphu-retted oxyde	‡ Phosphate of Mangan.	§ Silicate of mangan.	* Pitch Ore	‖ Uran mica.
Oxyde of manganese	92.75	82.	68.	85.	42.	52.60	—	—
Oxyde of iron . . .	7.	—	18.	—	31.	4.60	2.5	—
Silica	—	7.	3.	—	—	39.60	5.0	—
Lime	—	8.5	7.	—	—	1.50	—	—
Barytes	—	2.	4.	—	—	—	—	—
Sulphur	—	—	—	15.	—	—	—	—
Phosphoric acid . .	—	—	—	—	27.	—	—	—
Oxyde of uranium .	—	—	—	—	—	—	86.5	74.4
Oxyde of copper . .	—	—	—	—	—	—	—	8.2
Sulphuret of lead .	—	—	—	—	—	—	6.	—
Water	—	—	—	—	—	—	—	15.4
Loss	0.25	0.5	—		Volatile matter.	2.75	—	2.

* Klaproth. † Cordier and Beaunier. ‡ Vauquelin. § Berzelius. ‖ Gregor-

veins running though it make the red colour appear more brilliant.

Mrs. L. They are veins of sulphuret of manganese and oxyde of iron. In general, it is compact, but sometimes it has a threefold cleavage, which at first caused it to be considered as felspar coloured by manganese; this kind is in general paler than the compact variety.

Mary. This compact kind, I think, is a good deal like hornstone, except that it is more translucent; is it hard?

Mrs. L. Yes; it will scratch glass, and strike sparks with steel: the specific gravity is about 3.5.

Frances. Is it ever used for any thing ornamental?

Mrs. L. Yes, snuff boxes are made of it sometimes, but it is rather a scarce mineral.

Mary. Where is it found?

Mrs. L. In Siberia, and at Langbanshytta in Sweden. There is another species called helvine, of a bright honey-yellow colour which crystallizes in tetrahedrons, sometimes with the angles truncated. The specimens of a yellowish and grayish colour prove to be carbo-silicate of manganese, of which there are several species, not very well known at present.

CONVERSATION XIV.

MRS. L.

YOU will see the ores of several metals this morning; the first three are by no means extensive in their combinations, and scarce.

Frances. I see some beautiful green specimens, and apparently crystallized.

Mrs. L. They are hydrate of uranium, or uran-mica; but the first species is this black substance, known by the name of pitch-ore; it is an oxyde of uranium.

Mary. It is not very much like pitch; the lustre is so metallic, and the fracture so uneven.

Frances. It is very heavy, notwithstanding the specimen contains a great deal of some earthy substance.

Mrs. L. The specific gravity is about six and a half, which is greater than that of most minerals that have nearly the same appearance. Perhaps the most satisfactory experiment to determine whether a specimen is pitch ore, is to dissolve a small quantity in nitric acid; the solution will have a pale orange-yellow colour; and if you add any alkali to it, the uranium will be precipitated in the form of a yellow powder. The solution of the uran-mica is of a much brighter yellow: this circumstance will distinguish it from copper-mica.

Mary. I think I should never have occasion to make that experiment, to know the uran-mica, the light green colour is so vivid and so rich; it is more beautiful than any I have seen.

Mrs. L. It is certainly a delightful colour: but when you have seen some of the zinc and lead ores, you will not

be inclined to depend so much on that character, as on the crystallization.

Frances. Oh no, that is certainly the most decisive; these crystals, I think, are tabular, (figs, 317, 318, 319, 320.)

Mrs. L. Yes, the primitive form is a very low rectangular prism; sometimes these little tables or plates seem to adhere to the surface of the iron stone, or quartz, or other minerals with which they occur. Here are some of a sulphur colour, and here they are confusedly aggregated together.

Mary. Will it split like mica?

Mrs. L. It *can* be cleaved, but not with so much ease as mica, on account of its frangibility: the only distinct cleavage is that parallel to the base. The uran-ochre is another oxyde: it contains more oxygen than the pitch-ore. In general it occurs as a powder coating the pitch-ore, of different tints of yellow and orange. Sometimes it is indurated and massive.

Frances. Are any of these minerals found in England?

Mrs. L. Yes: they are all met with in many of the Cornish mines,* and it is found in Saxony and at Limoges in France. The ores of cerium are silicates and fluates. They are all dark coloured, and only one species has been observed crystallized—the pure fluate found at Finbo, in Sweden. The crystals are hexagonal prisms.

Mary. What kind of ore is this, with a fine splintery fracture.

Mrs. L. It is cerite, a silicate: the colour generally has a crimson tinge, with scarcely any lustre. If you scratch it, the streak is grayish white. Allanite contains 25 per cent. of iron, and is brownish and shining. Gadolinite contains also 45 per cent. of yttria, and is quite black, except in small splinters, which appear greenish when held between the eye and a strong light.

Frances. If it were not so heavy, it might be taken for a piece of coal fresh broken, the lustre is so shining.

Mrs. L. The specific gravity is about 4.; that of cerite,

* Particularly Carharrak, Tincroft, Tolcarn, and at Gunnis Lake, near Callington.

4.6. All these species will scratch glass, and give sparks with steel: gadolinite is even as hard as quartz.

Mary. Pray is gadolinite an English name?

Mrs. L. No; the mineral was named in Sweden, where it was discovered,* from Professor Gadolin, who first ascertained its composition. Like some of the earthy minerals, it gelatinizes with hot diluted nitric acid; and with borax, melts into a topaz-coloured glass.

Frances. What is this violet-coloured mineral imbedded in quartz?

Mrs. L. It is yttrocerite; a compound of three fluates; of lime, yttria, and cerium. It is sometimes in thin crusts, sometimes in lumps; and the colour occasionally reddish and light gray. It has never been found except at Finbo, where most of the other species occur. Orthite is a good deal like gadolinite; but instead of being found in small irregular masses, it forms thin straight veins in felspar and granite. The variety called pyrorthite contains 25 per cent. of charcoal, and takes fire before the blowpipe. There is also a subfluate of cerium of a yellow colour; but all these ores are very unimportant, as well as those of tantalum, which are both oxydes.

Mary. Do they crystallize?

Mrs. L. Yes, in oblique rhomboidal prisms; but both the crystals and irregular pieces are extremely rare, having been found in very small quantity in Finland, and more lately at Bodenmais in Bavaria; it is always nearly black; and internally shining, with an indistinct cleavage.

Frances. It is very much like some of the ores of cerium.

Mrs. L. Yes; but its high specific gravity is sufficient to distinguish it: it is from 7.1 to 7.9. The yttriotantalite very much resembles it, but it has a distinct cleavage, and the specific gravity is between 5.3 and 5 9.: it is about as hard as felspar. There is much more variety in the ores of cobalt; but some of them, the alloys and sulphuret, are so much alike, that you must have a good deal of experience in examining minerals, before you will find it easy to distinguish them from each other and from some other minerals. The alloys contain more arsenic than cobalt.

* At Ytterby.

Mary. Then, I suppose, the blowpipe would have nearly the same effect on them all.

Mrs. L. Yes, they all emit alliaceous fumes, and tinge borax blue. But there is a difference in the external characters of the three species. The tin-white cobalt crystallizes in cubes, either perfect or truncated on the angles, or in octahedrons. This is a very fine specimen from Saxony.

Frances. But all the cubes are cracked in various directions.

Mrs. L. That is its natural state; it is much more commonly found disseminated through mica-slate, in small foliated grains, very shining, and of a reddish white colour. All the alloys have a strong metallic lustre.

Mary. What is this compact, gray specimen?

Mrs. L. It is called gray cobalt ore; is is never crystallized, but is massive, or disseminated through quartz; the most brilliant of this family is the cobalt-glance.* You will have no difficulty I think, in understanding these crystals.

Frances. No, they are uncommonly perfect and brilliant.

Mary. They seem to be the same as those of iron pyrites.

Mrs. L. Yes, they are; those are from Modum in Norway, imbedded in copper pyrites; the other two alloys are found occasionally in Cornwall, but seldom well crystallized. The sulphuret of cobalt, or cobalt pyrites, is rarely crystallized, and very much like the gray ore, but the sulphureous vapour, which arises from it on the application of heat, distinguishes it. The oxydes of cobalt are always more or less earthy, and have therefore been called black, brown, and yellow, cobalt ochre. The black oxyde is sometimes considerably indurated.

Frances. I should think, as all these appear to be a good deal intermixed with other substances, particularly this dingy yellow oxyde,† that the best way or at least the shortest, to examine them, would be with the blowpipe.

* Silver-white cobalt ore.

† At Schemnitz in Hungary, and Allemont in France, the miners find a mixture of cobalt-ochre, arseniate of cobalt, and nickel ochre, with native silver, which they call goose-dung ore.

Mrs. L. Certainly, the result is very satisfactory; they generally form a thin crust on other ores. The arseniate sometimes occurs in the same situation; it is called cobalt bloom.

Mary. Is it this rose-coloured, glimmering mineral?

Mrs. L. Yes, that is the earthy arseniate, as well as the very small botryoidal concretions in the cavities of this gray cobalt.

Frances. And are these dark brownish crimson specimens, the same substance in a radiated form?

Mrs. L. Yes, they are composed of delicate acicular crystals, seldom large enough to have their form determined; they appear to be four or six-sided prisms obliquely terminated by two planes; it has been found in Scotland and Cornwall, as well as at several places in Saxony, Hungary, Salzburg, and Norway. The sulphate of cobalt is a soluble salt, of an earthy texture; it is generally in a stalactitic form, which consists of distinct granular concretions; this is from the Hartz.

Mary. It is very much like the arseniate, except being opake.

Mrs. L. It is only the crystallized arseniate that is translucent, or semi-transparent; but you will know this by its solubility. I am afraid I have shown you so many different ores that you will have but a confused notion of them. However, there are some properties peculiar to each species, which, if you recollect, they will materially assist you in distinguishing them; for instance, a blue colour may be produced by any of the cobalt ores. The ores of cerium and tantalum are mostly characterized by their dark colours and high specific gravity. Of the combinations of uranium, only the pitch ore is very heavy, but their colour, crystallization, and yellow solutions in nitric acid, will at once tell you that they can be compounds of no other metal.

Mary. I think I shall recollect these characters, because they seem to apply to the whole genus; but I assure you it will be long before I venture to give a name to a specimen.

Frances. But we had better always examine it in all possible ways before we ask its name. What is the next metal in your arrangement.

	* White cobalt ore.	* Gray cobalt ore.	† Cobalt glance.	‡ Cobalt glance.	§ Cobalt pyrites.	‖ Arseniate of Cobalt.	** Sulphate of Cobalt.
Cobalt . . .	9.6	12.7	36.7	44.0	43.2	—	—
Oxyde of cobalt	—	—	—	—	—	39.2	38.71
Arsenic . . .	68.5	50.	49.0	55.5	—	—	—
Iron	9.7	12.5	5.6	—	3.53	—	—
Copper . . .	—	—	—	—	14.4	—	—
Sulphur . .	7.0	—	6.5	0.5	38.50	—	—
Silica . . .	1.0	25.0	—	—	—	—	—
Water . . .	—	—	—	—	—	22.9	41.55
Arsenic acid .	—	—	—	—	—	37.9	—
Sulphuric acid	—	—	—	—	—	—	19.74
Stony matter .	—	—	—	—	.33	—	—
Loss	4.2	—	2.2	—	.04	—	—

* Laugier. † Tassaert. ‡ Klaproth. § Hisinger. ‖ Bucholz. ** Kopp.

Mrs. L. Nickel. It is found native, alloyed, and mineralized by oxygen and arsenic acid: its ores are found in veins in small quantity, and usually with cobalt.

Mary. Is this native nickel, or an alloy?

Mrs. L. It is nearly pure nickel; originally it is of a pale reddish bronze colour, but after some time, it requires a gray tarnish; it occurs always in capillary crystals; on charcoal, it melts before the blowpipe rather easily into a metallic globule, but it is supposed to contain a minute quantity of cobalt and arsenic.

It resembles some of the tellurium ores, but nickel has none of the properties peculiar to them. The ore called copper nickel contains nearly 50 per cent. of arsenic, and small quantities of other metals; it is nearly the colour of native copper, and always amorphous.

Frances. Will the blowpipe reduce it?

Mrs. L. Yes, but the globule soon darkens by exposure to the air; a knife scratches it with some difficulty, and it is rather frangible; the specific gravity is about 7.5. Another alloy of nickel, called glance nickel, has lately been discovered, nearly white and having a foliated fracture; it appears to be a combination of iron pyrites and arseniuret of nickel.

Mary. If I were to find it how should I know it?

Mrs. L. Perhaps there would be some difficulty in it; but you would find, after examining it, that it has not the same properties as other minerals that resemble it in some respects, and of which you know the names. But I am by no means sure that you will know any of these cobalt ores the next time you see them; it is more difficult than you imagine to determine their composition: in short, unless you know enough of chemistry to analyze your specimens, you must be content to trust to other persons in some degree, for information concerning them. But whenever you have the opportunity of seeing well marked and fine specimens of any substance, examine them well, that you may be able to know a similar one, when it comes in your way.

Mary. I shall always endeavour to recollect your advice, when I see any minerals.

Frances. And above all things, I shall look at the crystals.

Mrs. L. You will see a great variety presently in

tin ore. But you have not seen all the nickels. These light green earthy minerals, though very much alike, are two distinct species; this, which generally forms an earthy crust, is oxyde of nickel, or nickel ochre: the more massive specimens are arseniate of nickel. Some are very pale, or greenish white.

Mary. I really see no difference between them, except in their colour, and that does not seem to be essential.

Mrs. L. The blowpipe, by disengaging the arsenic acid, will show to which family it belongs, and if you melt borax with a little of the oxyde, it will become hyacinth-red. The only ores of molybdenum at present known are the sulphuret, which is found massive, of a blackish gray colour, and the ochre, which has not been correctly analyzed.

Frances. It appears to have a micaceous structure.

Mrs. L. Yes, the cleavage is parallel to the base of a rhomboidal prism which is considered as its primitive form. Sometimes it crystallizes in hexagonal plates: it is more like talc than mica, being flexible, but not elastic.

Mary. I think it is not exactly like any thing else I have seen; I should not mistake it for micaceous iron ore, because this is quite opake.

Mrs. L. Perhaps the most distinctive character is, that it will write on paper, but less strongly than plumbago or black lead; still there is so much similarity between them, that they were formerly confounded together—it is very soft, and feels greasy. In warm nitric acid, it effervesces, but does not entirely dissolve, and the specific gravity is between 4.5, and 4.8.

Frances. Is it found in England?

Mrs. L. Very sparingly in the granite of Cornwall, and in Cumberland; it is rather more abundant in Norway, and the United States.

There are only three ores of tin, and of these only one is smelted, which is nearly a pure oxyde.

Mary. I suppose it is abundant, as there are so many tin mines in Cornwall.

Mrs. L. Yes, it is plentiful in most of the places where it is found; but there are not many districts where tin occurs. There are three in Europe; one is between Saxony and Bohemia, in the range of mountains called the Er-

zegebirge; another in Gallicia, on the borders of Portugal, and the third is in Cornwall. It abounds in Siam and the island of Banka, and it has been discovered in Chili, and North America. I believe the Cornish mines have been worked longer than any others; for it was from them that the Phœnicians procured the tin which they used in making their armour; they alloyed it with copper.

Frances. I suppose tin would be too soft by itself.

Mrs. L. Yes, the mixture of the two metals is much harder than either of them separately; bell-metal is an alloy of this kind. This mineral has been called bell-metal ore.

Mary. Is bell-metal obtained from it?

Mrs. L. No, it has only been found at three or four places in Cornwall, and in small quantity. The yellowish tinge on it, is not a tarnish; the colour is between that of brass and steel.

Frances. It is like iron pyrites, except in being grayer.

Mrs. L. It is something like it in fracture too; in one direction foliated, in the others small conchoidal. It is also called tin pyrites, and is generally intermixed with copper ores; in most of the Cornish mines, both copper and tin are raised. It is rather curious, that the specific gravity of tin is not quite 7.3, and the oxyde has a specific gravity between 6.8 and 7.0, while among the ores of copper and iron, scarcely any have a specific gravity above 5.

Mary. I was surprised on taking this up to find it so heavy. How brilliant these dark crystals are.

Mrs. L. They are oxyde of tin, or tin-stones. Brownish black is their most common colour, but I have some nearly colourless, and quite transparent.

Frances. Some of these bright brown crystals are near-

Analysis of Tin Pyrites, by Klaproth.

Tin.	Copper.	Iron.	Sulphur.	Loss.
26.5	30.	12.	30.5	1.

ly transparent, but the large black and reddish ones are opake.

Mary. They all seem to be square prisms terminated by pyramids. What is the primitive form?

Mrs. L. It is a flat octahedron, with a square base, (fig. 321.) but it is never found without a prism intervening between the two pyramids. These (figs. 322, 325.) are the commonest of its crystallizations, except the macles, some of which are abundant, particularly this, (fig. 332.)

Frances. Most of these are so much imbedded in the quartz and mica, that I can only see half, or a small part of them.

Mrs. L. You will see quartz and mica with most of them; and in some specimens, a variety of other minerals, Here is one where I think you will know them all.

Frances. Here are quartz and mica again; and I think these cubes are fluor: and here is pyrites, but I do not know which kind.

Mrs. L. Try if you can find out, Mary.

Mary. I see no foliated fracture, and where there is some indication of a regular form, the angles are certainly not those of a cube; it must be copper pyrites.

Mrs. L. You are right.

Frances. I cannot remember what these pale lilac crystals are; they are not crystallized like fluor.

Mrs. L. They are very imperfect, or I think you would have known them to be phosphate of lime. Sometimes, tin-stone is found with topazes and chlorite, but seldom with lead or silver ores: the acute pyramidal crystals are much less common than the others—these are from Bohemia. (figs. 328, 330.) Mr. Phillips, who has spent a great deal of time in examining the different crystallizations of tin-stone, and has sacrificed many crystals to ascertain their cleavage, has enumerated twelve* modifications, which, by different combinations with the primitive presented about two hundred varieties of form. The cleavages are parallel to the sides and the diagonals of the prism, and to the faces of the octahedron.

Frances. That is a greater number than you find in most minerals, I should think.

* See Transactions of the Geological Society, vol. ii.

Mrs. L. Yes, few have so many. You may remark, that though the crystals of tin-stone have a splendent lustre, the fracture is almost dull; and when you scratch it, the streak is grayish white,—look.

Mary. It is indeed, and the powder is of the same colour.

Mrs. L. Sometimes the crystals are extremely small, and quite intermixed with mica; and it is found in some places, amorphous, with a somewhat granular structure: it has then, the appearance of pebbles from the size of a fist to that of sand: these deposits usually occur in low marshy ground, and sometimes grains of native gold are found with them. It is called stream-tin, because, when it is worked, the earthy matter with which it is intermixed, is separated by passing streams of water over it. At Finbo in Sweden there has been discovered an oxyde of tin, containing from two and a half to twelve per cent. of oxyde of columbium: it is said to occur in small octahedrons and grains, imbedded in granite.

Mary. Are these some of them? they are marked with light coloured spots and rings.

Mrs. L. No, they are another subspecies, called wood-tin; it has only been observed in Mexico and Cornwall; the structure is diverging fibrous, and, in general, very delicate. It has a great deal of similarity to hæmatite, and was, at one time, confounded with it.

Frances. It has very little lustre: is it the same substance as the crystallized oxyde?

Mrs. L. Yes; it only differs in form and texture.* It

*	* Tinstone.	† Tinstone.	‡ Tinstone.	§ Wood-tin.
Oxyde of tin	99.5	95.	93.6	91.
——— tantalum	—	—	2.4	—
——— iron	0.5	5.	1.4	9.
——— manganese	—	—	0.8	—
Loss	—	—	1.8	—

* Klaproth † Collet-Descotils. ‡ Berzelius. § Vauquelin

is always found in rolled pieces, which are seldom larger than a cherry; but Mr. Mawe has a piece from Mexico, which weighs ten ounces and a half: the specific gravity is about 6.4.

Mary. Will the blowpipe reduce it to a metallic state?

Mrs. L. Only in part, when it is put on charcoal. The process of smelting tin is very tedious, and consists of a great many operations. I shall not show you any thing more this morning, because there are several ores of titanium, and two are very much like each other.

CONVERSATION XV.

MRS. L.

I ADVISE you to pay attention to the *external* characters of the minerals in this family; for the *chemical* ones, you would not find it easy to examine, nor, perhaps, very satisfactorily, till you know a great deal more of chemistry; it is so extremely difficult to reduce them to a metallic state. The two pure oxydes, I think you will easily recollect when you see them again. The rutile is generally of a red colour, and sometimes crystallized, sometimes radiated or fibrous.

Frances. That is a very beautiful colour.

Mary. I think it is what you call hyacinth-red.

Mrs. L. Yes, it is: this is chérry-red. I have also a variety, extremely like gold: it occurs in small patches, which consist of delicate fibres intersecting each other.

Frances. I think it would not be very surprising if I mistook it for gold.

Mrs. L. This is slightly translucent, but if you cannot perceive that, heat it with the blowpipe, and it will become brown and opake. The red fibrous specimens are very much like red schorl, and before the metal titanium was known, were arranged with it, though the specific gravity is about 4.2. This is not so surprising, however, as it may appear, for when mineralogy was little understood, and crystallography still less, an immense variety of substances were classed together; and if they were crystallized, (particularly in a prismatic form,) they were generally called

schorl:* the crystals are six or eight-sided prisms, and occasionally, two are jointed together, (fig. 334.)

Mary. That is a very singular twin crystal.

Frances. Is rutile found in England?

Mrs. L. It was discovered about thirteen years ago on Snowdon, in very complicated crystals, which were figured by Mr. Sowerby, in his British Mineralogy; and it is found at Cairn-Gorm in Scotland, and in various parts of Europe and America; most frequently in quartz, or with adularia and chlorite. When it is in delicate parallel fibres, enclosed in rock-crystal, it is sometimes cut into ornaments, and called Venus's hair. The anatase, or octahedrite, is apparently a very different substance. Here are some crystals from Dauphiné, (figs. 335, 336, 337.)

Mary. They seem to be long octahedrons.

Mrs. L. Yes, the base of the pyramids is square. This is another example of what I just now said to you; octahedrite was once named blue schorl. The crystals are small, but in general, very perfect, shining, and not imbedded in the substance they occur with, but appear resting on it; sometimes they are brownish, but always translucent: the specific gravity is nearly 4.

Frances. And what is the difference between this mineral and rutile?

Mrs. L. The only chemical difference is, that it contains a little more oxygen. There are three other oxydes, all containing iron, which are only found in the state of sand: iserine and menächanite differ so little in composition and appearance, that I think they may be considered as varieties of the same species; they both attract the magnet, but so slightly, that you would not mistake them for iron sand.

Mary. And that is the only mineral I have seen that I *could* mistake them for.

Mrs. L. Nigrene occurs in rather larger grains, and is not attracted by the magnet at all, probably because it contains less oxyde of iron than the other two. The family of salts contains only one mineral, called sphene, which is a silicate of titanium and lime.

* See Ferber's Travels, where almost every crystallized mineral is denominated schorl.

Frances. Are these detached crystals, sphene?

Mrs. L. Yes; those are twin crystals; but the most perfect I have, are dispersed over that specimen of adularia and chlorite.

Mary. That is a beautiful specimen, indeed; every part of it seems so perfectly crystallized; the quartz, the adularia, the chlorite, and the sphene: but the crystals are complicated.

Mrs. L. Here are some models of them, which will perhaps be more intelligible to you, (fig. 39.) This (fig. 338.) is considered to be the primitive; but it does not occur unmodified: those brownish red ones (fig. 340.) resemble grenatite a little, being opake.

Frances. These transparent ones are extremely pretty, one end is greenish yellow, and the other a bright hyacinth-red.

Mrs. L. Those are from Salsburg; and the pale green ones which contain chlorite disseminated through them, are from the mountain St. Gothard: very fine ones, nearly two inches in length, have lately been brought from the Grisons; they have generally a splendent lustre, unless they are incrusted with chlorite.*

Mary. I think I shall know these again when I see them, there is so little variety in the external characters of each species.

Mrs. L. You will find the ores of zinc also very well

	* Menachanite.	†	‡ Iserine.	§ Nigrine.
Oxyde of titanium . .	43.5	45.25	41 1	63.
——— iron	50.4	51.	39 4	35.
——— manganese .	0.9	0.25	—	2.
——— uranium . .	—	—	3.4	—
Silica	3.3	—	16.8	—
Alumina	1.4	—	3.2	—
Loss	0.5	—	—	—

* Lampadius. † Klaproth. ‡ Thomson.
§ Vauquelin and Hecht.

* See table, page 264.

characterized; they are few in number, but not scarce. At present it is found in the states of a sulphuret, an oxyde, and combined with silica and two other acids. The sulphuret is called by mineralogists, blende, and by miners, black jack.

Frances. Then I suppose it is black or nearly so?

Mrs. L. There are three varieties, yellow, brown, and black: the yellow is considered to be a pure sulphuret of zinc: and the greater opacity and darker colours of the other varieties, are caused by an intermixture of iron.†

Mary. Is this yellow blende? It is not a very bright colour.

Mrs. L. Yes; the yellow inclines to green, and sometimes even passes into it, or it is brownish. You will not often see crystals so transparent as these. Some of it is phosphorescent when it is scraped or rubbed, even under water.

Frances. The lustre of the fracture is extremely brilliant.

Mrs. L. It is adamantine—but that is not properly a fracture; it is a cleavage, and blende has six, parallel to the planes of the rhombohedron, its primitive form. Sometimes it is massive, but always with a lamellar structure. Brown blende, you have already seen on many specimens of quartz and pearl-spar.

Mary. Yes, in small shining crystals—dark brown or reddish, like garnets.

Frances. The faces of these appear to be convex, so that I cannot understand them.

* Sphene.	*	†
Oxyde of titanium - - - - - -	33.	58.
Silica - - - - - - - - - - - -	35.	22.
Lime - - - - - - - - - -	33.	20.

* Klaproth. † Abilgaard.

† *Analysis of brown blende, by Dr. Thomson.*

Zinc - - -	59.09
Sulphur - - -	28.86
Iron - - -	12.05

Mrs. L. That is frequently the case with blende, and the modifications take place in a curious way with regard to the primitive. Here are some very perfect ones, (fig. 345.) but I have some that I have examined several times without being able to determine their form, because they are partly imbedded.

Mary. I think the small ones are very much like the little crystals of tin-stone.

Mrs. L. They are at first sight, when aggregated together: but the forms are so different from those of tin-stone, that a good magnifier will at once enable you to distinguish them; and you may remark that the specific gravity of blende is only about 4., and the streak, yellowish brown; both these characters will distinguish the brown blende from wolfram, which it resembles a good deal.

Frances. Here is a fibrous specimen very much like blende in colour and brilliancy: is it the same substance?

Mrs. L. Yes; it is radiated blende from Prizbraim, in Bohemia; it contains several per cent. of cadmium; indeed, it was in this that cadmium was first discovered.

Mary. What is this, Mrs. L., on the other side of the specimen? It appears quite metallic.

Mrs. L. It is sulphuret of lead; a mineral almost always found with blende, whether it occurs in lead mines or in distinct beds. If you examine these specimens minutely, you will scarcely find one, on which there is not some of it.

The black blende is, in general, less translucent than the other varieties: but in small fragments it appears blood-red, when held between the eye and the light. Here is a little bit.

Mary. The colour is extremely deep.

Mrs. L. The oxyde of zinc is of a beautiful cherry-red colour; it has only been found hitherto in North America, in the iron mines of Sussex county. It does not crystallize, but the structure is lamellar.*

* *Analysis of Oxyde of Zinc, by Dr. Bruce.*

Zinc - - - -	76.
Oxygen - - - -	16.
Oxyde of iron and manganese	8.

Frances. Is this magnetic iron-stone, it is so much intermixed with?

Mrs. L. Yes. The colour is lighter, and rather more approaching to orange, than that of red oxyde of copper. It is soluble in the mineral acids, but does not fuse before the blowpipe. The three following species were formerly confounded together under the name of calamine; afterwards, the silicate was distinguished from the others, by its property of becoming electric when it is heated; but it was not until after many experiments had been made by eminent chemists, that the composition of them was accurately known. They are all found in the lead mines of Great Britain, but the silicate, only in Leicestershire, Flintshire, and Wanlock Head, in Scotland. There are some very perfect crystals on these specimens, (figs. 346, 347.)

Mary. I suppose they are the small deep yellow coloured crystals, for all the rest seem to be carbonate of lime and pyrites.

Frances. I remember this crystallization of carbonate of lime, which Mrs. L. said was found principally in Leicestershire.

Mrs. L. The crystals of electric calamine are, in general, very small, and either single, or aggregated in little bundles. The carbonate of zinc is much more plentiful; it is sometimes crystallized, and frequently massive and compact; the crystals are always so heaped together, that it is scarcely possible to determine their form; they line the cavities of brown iron-stone, and other substances which occur with them.

Mary. These have a sort of radiated arrangement, but there are no single crystals.

Frances. That specimen is very much like one of sulphate of lime that I recollect to have seen, in delicate tabular crystals.

Mrs L. They are mostly tabular, and grayish or yellowish white; but sometimes a brilliant light green, which is a much scarcer variety.

Mary. Here is a light green specimen, but the crystals are so minute, that it looks like a piece of beautiful moss.

Frances. But how would you find out that it is calamine,

and distinguish it from so many minerals of the same colour?

Mrs. L. I think, if you compare it with all the minerals you have seen, you will find very few of the same tint of green; and, if you recollect, I told you it was a *carbonate* of zinc.

Frances. Oh, true; the effervescence with acids would show it was a carbonate; and the carbonate of copper, I think, does not appear in this form.

Mrs. L. The structure of calamine is lamellar, and sometimes a little curved. The compact kind is found massive, and in thin parallel distinct concretions, which have a botryoidal form; and more rarely it occurs in pseudo-crystals.

Mary. Are they hollow?

Mrs. L. Sometimes; but occasionally they are filled with the substances they have incrusted, which are usually carbonate and fluate of lime.

The earthy calamine contains about 15 per cent. of water; it is in general full of cavities, and impressions of crystals, and has a good deal of resemblance to cellular quartz: it is opake and earthy, and adheres to the tongue.

Frances. And it appears to be very soft; I suppose its specific gravity is greater than it seems, from its being cellular.

Mrs. L. The specific gravity of this species is nearly 3.5; that of the crystallized calamine 4.3; and of the red oxyde of zinc 6.22.

Mary. Which of the ores is used in England for obtaining zinc?

Mrs. L. Both the blende and the calamine. Formerly the blende was entirely neglected, but it is now used in the proportion of one part, to two of calamine. The oxyde, which is abundant in America, is a far more profitable ore; it is melted with copper for the manufacture of brass, without any previous reduction. I forgot to tell you that the electric calamine is soluble in the mineral acids when warm, and on cooling, it gelatinizes. Sulphate of zinc, is a semi-transparent salt, of a grayish or reddish white colour; it is supposed to be formed by the decomposition of blende, as it occurs with it; do you see how that might take place?

Frances. Let me see,—blende is a sulphuret of zinc, and the sulphur it contains must unite with oxygen and become sulphuric acid, to form sulphate of zinc.

Mrs. L. You are right; the process would be the same as in the production of sulphate of iron from pyrites. You will see few specimens of the bismuth ores, for they are scarce minerals; they occur principally in Saxony; and the native bismuth is more common than the other species. This is from Schneeberg.

Mary. It is very much like one of the cobalt ores, both in colour and lustre.

Frances. Yes; and like the native tellurium.

Mrs. L. It is softer and more sectile than the cobalt ore, and its chemical properties are very different from those of cobalt and tellurium; it is easily melted, and converted into a metallic globule by the blowpipe; and by continuing the heat, it is volatilized in the form of a white smoke, which may be condensed on a piece of charcoal held over it: it mostly occurs intermixed with cobalt ores.

Mary. Has it always this foliated granular appearance?

Mrs. L. No; it is sometimes crystallized in acute rhombs and octahedrons.

Frances. And which of the two is the primitive?

Mrs. L. The rhomb most probably, as it appears to have a threefold cleavage. Occasionally it is found like native silver, in leaves and dentritic forms, in quartz or hornstone, and other substances. It has been obtained from some of the Cornish mines in small quantity. The sulphuret of bismuth has a darker colour, and less lustre.

Analysis of Zinc Ores, by Mr. Smithson.

	Silicate.	Carbonate.	Hydrous Carbonate.
Oxyde of zinc	68.3	64.8	71.4
Silica . . .	25.	—	—
Water . . .	4.4	—	15.1
Carbonic acid	—	35.2	13.5

Mary. Will the blowpipe volatilize the sulphur?

Mrs. L. Yes; but the greater part of the metal is volatilized by the heat at the same time: it melts even in the flame of a candle.

Frances. Is this sulphuret of bismuth, Mrs. L.? there seem to be two kinds of metal, one partly enclosed in the other, and the whole imbedded in quartz.

Mrs. L. It is a sulphuret containing copper and lead, called needle ore, from its occurring in acicular crystals; it is enclosed in sulphuret of lead; there is another species found only in the mines near Wittichen in Furstemberg.* If you melt them with a blowpipe, you will see by the globule of metal that remains, to which species they belong. The oxyde of bismuth is a light green ochry mineral, like the nickel ochre in external appearance.

Mary. Is it easy to distinguish them?

Mrs. L. There are two methods; the most simple is to dissolve a little in one of the mineral acids, and add a considerable quantity of water; if it be an ore of bismuth, the oxyde of bismuth will be precipitated in the form of a white powder.

There is very little variety in this genus, but in the next, a great deal.

Frances. Is it the lead genus? I see some specimens exactly like the sulphuret of lead, with a very distinct rectangular cleavage in three directions.

Mrs. L. That is sulphuret of lead; it is commonly called galena. The cleavages are very easily obtained, even by

*	* Sulphuret of Bismuth.	† Cupreous Sulphuret.	‡ Needle Ore.
Bismuth	60.	47.24	43.20
Sulphur	40.	12.58	11.58
Copper	—	34.66	12.10
Lead	—	—	24.32
Nickel	—	—	1.58
Tellurium	—	—	1.32
Loss	—	5.52	5.90

* Sage. † Klaproth. ‡ John.

dropping a piece on the floor; for though it is soft, it is very frangible: but you have overlooked the first species, native lead.

Mary. I suppose, from being such a small piece, that it is very scarce.

Mrs. L. It is extremely rare; this was discovered at Holywell in Flintshire, where there are lead mines: galena, on the contrary, is a very abundant ore in many countries; by far the greater part of the lead used in the different manufactures is obtained from it. The most common crystals are octahedrons, and cubes with their angles deeply truncated, (figs. 350, 349.) but it takes forms derived from the cube. The crystallized specimens are generally very pretty, from its being associated with carbonate and fluate of lime, pearl-spar, sulphate of barytes and quartz; as well as other ores.

Frances. The colour is very much like that of lead; is there much difference in their specific gravity?

Mrs. L. The specific gravity of galena is between 7.5. and 7.8. that of lead, you know, is above 11; the crystals generally appear resting on those of the other minerals, like those of blende and calamine, and not imbedded.

Mary. There are beautiful iridescent colours on this specimen; is that uncommon in galena?

Mrs. L. No; they do not extend below the surface. Here is another variety, called compact or steel grained galena from its texture; it has less lustre than the other, and does not crystallize.

Frances. Are both kinds found in England?

Mrs. L. Yes; but the compact galena is much more scarce than the other. Galena often contains a little silver; sometimes as much as 15 per cent. in the lead obtained from it. When this is the case, it is worked for the sake of the silver it contains.

Mary. But I suppose the lead is procured from it too?

Mrs. L. Yes; the lead is first procured from the ore in the usual way; it is afterwards separated from the silver by a process called cupellation; while it is in a state of fusion, a current of air passes over it, which oxydates the lead and converts it into a yellowish scaly substance called litharge; this is blown off by the draught of air, and is again formed on the surface of the melted metal, till the silver,

which is not affected by the oxygen of the air, remains nearly pure at the bottom of the furnace; a second cupellation removes the small quantity of lead which was left by the first operation.

Frances. But is all the lead wasted?

Mrs. L. No; the greater part of the litharge is reconverted into metallic lead by the same means as are employed to reduce the ore. Some of it, however, is used in that state.

When the fracture of galena is slightly fibrous, it contains a little antimony; the species, called antimonial sulphuret, contains about equal parts of lead and antimony; it has a very peculiar glistening lustre, and is not uncommon in the English lead mines.

Mary. It is dentritic, and contains small crystals of carbonate of lime.

Mrs. L. This is a very curious substance, though it has nothing remarkable in its appearance; it is a kind of galena, which is found in Derbyshire, lining the sides of very narrow rents or fissures in the rock, and, from the smoothness of its surface, is called slikenside or sleekinside.

Frances. Is it not curious on account of its smoothness and shining lustre?

Mrs. L. No; but if it is struck, when in its original situation in the mine, with a hammer or any other hard substance, so as to break the surface, it crackles and then breaks to pieces with an explosion.

Mary. How very strange; and will this explode in the same manner if you scratch it?

Mrs. L. No; not after it is removed from the rock. The miners are aware of this property, and I was told by one (when I was in Derbyshire,) that if they find out the slikenside before any accident occurs, they go out of the way, leaving one man, who hits it with a nail fastened to the end of a long pole, and runs away to avoid the effects of the explosion. This man had been wounded by the sudden breaking of some slikenside; and of his eight companions, some were wounded, and some killed.

Frances. And has this never been accounted for?

Mrs. L. Not satisfactorily.

Frances. And what are these black hexagonal prisms? Here is a large group of them.

Mrs. L. It is called blue lead ore, but the colour is dark blueish gray—it is only black and dull externally: these are not perfect hexagonal prisms, but are thicker in the middle than at the terminations. (fig. 353.)

Mary. So they are; I never observed that in any other substance.

Mrs. L. The prisms of arseniate of lead have the same form: this species has not been analyzed; it has only been found at Schoppau in Saxony, and Huelgoet in France: those are specimens of bournonite.

Frances. Pray was it named after the Comte de Bournon, whom I have heard you speak of as a mineralogist and crystallographer?

Mrs. L. Yes, he first described it, and examined its crystallizations: he had called it endellion, because it was discovered in a parish of that name in Cornwall.

Mary. I cannot understand the crystals, because they are so closely aggregated, that I can only see a small part of them.

Mrs. L. They seldom occur single; and as they are divisible by cleavage into two prisms, a rectangular and a rhombic one, there might be some doubt respecting the primitive form. Bournon considered it to be a square prism, but Mr. Phillips and Mr. Brooke, have lately determined it to be a rectangular one.* (fig. 354.) The crystals always exhibit several modifications.

Frances. I should think the cleavages were not easily obtained; for the fracture of these appears to be uneven.

Mrs. L. They are not very distinct; it is brittle, and, in hardness, is intermediate between carbonate of lime and fluor—the crystals are dull and nearly black externally, but the colour of the fracture is dark gray.

Mary. What is the difference in the composition of this and galena?

Mrs. L. It contains sulphuret of antimony, of copper, and of iron; it decrepitates and splits before the blowpipe, and the antimony and part of the sulphur are volatilized, leaving a globule of copper incrusted by sulphuret of lead.

Frances. And what becomes of the iron?

* Annals of Philosophy for Nov. 1821. p. 360.

Mrs. L. The quantity is so small (from about 1 to 5 per cent.) that it is not rendered visible by this operation. There is also an ore of lead containing cobalt, and another containing a good deal of arsenic; but both are extremely scarce: the two natural oxydes are also very rare.

Mary. Have you any of them?

Mrs. L. Yes; this is the yellow oxyde from Siberia; it has a good deal of resemblance to yellow jasper.

Frances. Yes, but its weight would distinguish them, and I suppose it is a great deal softer than jasper.

Mrs. L. Yes; a knife will scratch it easily; the specific gravity is 8. In the less compact varieties, there is an indistinct threefold cleavage; both this and the red oxyde are easily reduced on charcoal—you have seen the red lead used in painting?

Mary. Yes; is this scarlet earthy mineral the same substance?

Mrs. L. Precisely; this is supposed to be produced by the decay of galena; which is very probable, for sometimes it occurs in cubes, or contains galena within it; it is not so beautiful a colour as the light red cinnabar.

Frances. No; this inclines to orange, and is less compact.

Mrs. L. This ore has been met with in the lead mines of Yorkshire, as well as some places on the Continent.—The next family is extensive, and presents a good deal of variety. The combinations of lead with the different acids are rather numerous.

	*	*	†	‡	§
	Galena.			Bournonite.	Antimonial Sulphuret.
Lead	69.	64.	85.13	42.5	43.44
Antimony	—	—	—	19.75	42.26
Copper	—	—	—	11.75	0.18
Iron	—	—	0.5	5.	0.16
Arsenic	—	—	—	—	3.56
Sulphur	16.	18.	13.02	18.	17.20
Lime and Silica	15.	18.	—	—	—
Loss	—	—	1.35	3.	—

* Vauquelin. † Thomson ‡ Klaproth. § Pfaff.

Mary. I think the acidiferous ores have seldom any metallic lustre: they resemble earthy minerals very much in their external characters.

Mrs. L. You see, therefore, the necessity of being acquainted with the means of ascertaining their composition. The carbonate of lead is an ore more frequently met with than any other except galena. I do not know whether you will find any resemblance in these specimens, to those you have seen.

Frances. From their great weight, I think it is very likely that I might mistake them for sulphate of barytes: but some of these crystals have a peculiar brilliancy, different from the lustre of any thing I remember.

Mrs. L. The internal lustre is always adamantine, though the surface of the crystals varies from that, to dulness. Indeed, it exceeds the diamond in brilliancy when it is transparent; and if it were sufficiently hard, would doubtlessly be preferred to it as a precious stone. This is owing to its very high refractive power.

Mary. Does it refract doubly like carbonate of lime?

Mrs. L. Yes, in a high degree; but it is seldom very transparent. The primitive crystal, which rarely occurs, is a rectangular octahedron. Here is one that I obtained by splitting a crystalline fragment. (fig. 357.)

Frances. It is something like the octahedron of phosphate of copper.

Mary. Are not these like quartz crystals? (fig. 360.)

Mrs. L. Yes; but the angle made by the planes of the prism and the pyramid, is different from that of quartz; and the base of the prism, or a section perpendicular to the axis, is not a regular hexagon.* Carbonate of lead is generally crystallized, but sometimes massive and intermixed with the galena or copper ores that frequently occur along with it: this is a pretty variety.

Frances. Oh! I have seen something exactly like that before, though I do not remember what it was.

Mrs. L. It was the columnar sulphate of barytes: this is from Shropshire. It is tinged by the brown iron-stone

* In each of these prisms, (358 and 360,) two angles are formed by the meeting of the primitive planes, and are 117° 18′. The remaining four are each 121° 21′.

that occurs with it; and several of these specimens are of beautiful blue or green tints, in consequence of being associated with carbonate of copper.

Mary. I suppose it would not be difficult to distinguish this from the sulphate of barytes, as it is a carbonate.

Mrs. L. No; the effervescence with acids is a very simple test. It will also prevent you from mistaking the earthy variety for earthy calamine; they are a good deal alike. The friable earthy carbonate generally has a yellow tinge; and the indurated kind is of different shades of gray and light brown. These are crystals of carbonate of lead, of which the external part has been reduced to a metallic state, or rather to the state of a sulphuret, while the centre retains its original transparency.

Frances. Here is a broken one, which shows it very plainly.

Mary. How does that change take place in them?

Mrs. L. It is most probably occasioned by sulphuretted hydrogen, produced by the decomposition of galena. I will show you how it acts, directly: here is a little powdered carbonate of lead, and a small cup, containing sulphuret of potash, on which I will pour some nitrous acid*, and cover the whole with a glass bell, to prevent the escape of the gas produced, which is sulphuretted hydrogen.

Mary. How violently it effervesces!

Frances. It is already beginning to blacken the carbonate of lead.

Mrs. L. The property of becoming black, by exposure to sulphuretted hydrogen, is a good distinctive character between this ore and the minerals it most resembles. The next species is the murio-carbonate, a much rarer substance. It has only been observed crystallized, in Derbyshire and some parts of Germany and America.

Mary. Here is a beautiful crystal (fig. 362.) a square prism terminated by pyramids: but it appears a little twisted.

Mrs. L. Many of the long prisms have that appearance; but the shorter ones are quite straight. There is a remarkably fine crystal of this form (fig. 363.) in the Bri-

* Any other mineral acid will do equally well.

tish Museum, from Derbyshire: it is nearly two inches in diameter. It has a brilliant adamantine lustre, but is rather softer than carbonate of lead, and easily frangible, but sectile. The specific gravity is 6. The cleavages are parallel to the sides of a square prism, but the cross fracture is conchoidal.

Frances. Does it occur of no other colour than yellowish white?

Mrs. L. It is sometimes colourless, and sometimes the yellow tinge is a little deeper than in this specimen. The colour of phosphate of lead passes from pistachio green into honey yellow, and deep orange, and different tints of brown: it has been distinguished into different subspecies, according to its colour, but their composition and crystallization are exactly the same: these specimens are from Siberia, and are very well crystallized.

Mary. The crystals are rather small; but I can see two or three forms like those of emerald.

Frances. They are hexagonal prisms; some of them have the terminal edges truncated.

Mrs. L. It is not very uncommon to find the prisms terminated by low pyramids, similar to the terminations of phosphate of lime (figs. 212, 213, 214.;) indeed there are no crystals of this substance which may not be found in apatite. The orange-coloured variety is from Lead-hills in Scotland. Here is one exactly like the green calamine you admired.

Mary. It is indeed; I should think it impossible to know them by their external appearance.

Mrs. L. When phosphate of lead is exposed to the action of the blowpipe, on charcoal, it decrepitates a little, and then melts, and when it is cooled very slowly, assumes a polyhedral form, and the faces exhibit numerous concentric polygons; but this does not take place till it has been some minutes in a state of fusion, and when you are beginning to withdraw it from the hottest part of the flame. This is a little bead I obtained by such a process.

Frances. How very brilliant the faces are; it appears quite metallic.

Mrs. L. I do not know any thing you could mistake it for, after making this experiment. Phosphate of lead is soft, but not so frangible as carbonate of lead. The green

crystals are usually transducent on the edges, and have rather a waxy appearance.

Frances. So I perceive. Is this botryoidal specimen another variety of the same substance?

Mrs. L. No, that is arsenio-phosphate; it contains 7 per cent. of arsenic acid, and has a fibrous or radiated fracture; this has not been found in England hitherto. One of the most beautiful lead ores is the chromate, which is peculiar to a gold mine near Ekaterinebourg in Siberia. It only occurs crystallized, and of a colour called aurora-red.

Mary. That is a beautiful colour, and I think different from any other I have seen.

Mrs. L. It is intermediate between blood red and bright orange.

Frances. Are not these crystals four-sided prisms?

Mrs. L. Yes, acuminated by four planes (fig. 364.;) and some of them have other additional faces.

This is the result of a singular modification, (fig. 366.) which takes place on only one of the lateral edges. It is difficult to understand the crystallizations of this mineral: one or two planes are generally much larger than the rest, and give them an appearance of irregularity; and several crystals are often grown together. When it is reduced to powder, it is of a rich yellow colour.

Mary. It is a great pity it is so scarce: I should think it might be used for painting.

Mrs. L. Chromate of lead is prepared artificially for that purpose, and is one of the finest yellows that can be used in oil painting. The chromic acid is obtained from the chromate of iron, which is found abundantly in North America; and the colour is generally called chrome yellow.

Frances. I believe, then, I have seen it: but is it permanent? For I remember you once told not to paint any thing with red lead or flake white, because they would change to lead in a little time.

Mrs. L. Yes, because the flake white is carbonate of lead; and there is a great deal of sulphuretted hydrogen always floating in the atmosphere of large towns. But the chromate of lead is not affected by any of the gases that are so abundant in the air of London. The yellow coach-bodies are now generally painted with it, instead of the

submuriate of lead that was formerly used for that purpose. The specific gravity of it is 6. The sulphate of lead is not very plentiful. The best crystals I have are from the Parys mine in Anglesea.

Mary. What is the mineral these crystals are partly imbedded in? (fig. 369.) It has the appearance of a brown cinder.

Mrs. L. It is cellular quartz coloured by iron ochre, and intermixed with iron pyrites: the crystals are generally small; the primitive form is a right rhombic prism, (fig. 367.) which is in general so modified as to have the appearance of an elongated octahedron, (fig. 371.) or a figure derived from it. (fig. 370.)

Frances. Some of them are rather complicated.

Mrs. L. Yes; but with a glass I think you will not find it difficult to see most of the planes; they are in general very regular.

Mary. Is this the same substance, Mrs. L., in thin, flat, shining pieces attached to galena?

Mrs. L. Yes, that is from Lead-hills; it is a good deal like some of the tabular varieties of the sulphate of barytes, but has a much more brilliant lustre externally. The specific gravity is about 6.3, a little less than that of carbonate of lead.

I have a singular specimen of galena enveloped in sulphate of lead, which has nearly the appearance of clay iron stone. You see there is a good deal of galena diffused through the whole mass.

Frances. Do you think it might once have been entirely galena, and that the sulphur has become sulphuric acid?

Mrs. L. You have given a very good explanation of it, and most likely the true one. There is very little variety in this species; and not more in the next, which is molybdate of lead.

Mary. Is not that lead combined with acid of molybdena?

Mrs. L. Yes; it is very seldom found in masses, mostly in small crystals of a wax or honey-yellow colour.

Frances. Some of them are very flat octahedrons, and some are thin tables, like those of uran-mica.

Mrs. L. This flat octahedron (fig. 372.) is the primitive; it has a square base; and you may imagine the octagonal

tables to be produced by truncating the summits very deeply, and then truncating the edges and angles of the base. (fig. 374.)

Mary. I think there are several minerals something like this; therefore I hope it has some peculiar character or property by which I may know it again.

Mrs. L. If you dissolve a little in hot sulphuric acid, the solution will have a blue colour; that is a very simple experiment: or if you submit it to the action of the blow-pipe, you will find that it fuses into a yellowish-gray glass, and part of the lead is reduced to metallic globules. It is found in Austria, Transylvania, the Tyrol, Carinthia where it was first discovered, and Massachusetts, in North America. The arseniate of lead was a very rare mineral till a good deal was discovered some years ago in Cornwall. It occurs in thin hexagonal prisms which rest upon crystals of quartz and steatite; these are from the mine Huel Unity, in Cornwall.

Frances. How very silky their lustre is; they look like a collection of delicate fibres.

Mary. I do not see any regular terminations.

Mrs. L. They very seldom occur; but sometimes the terminal edges of the prism are replaced by narrow planes. It is generally of a brownish or straw-yellow colour, but it is said to have been observed grass-green. This reniform variety is from Siberia; and there is another having nearly the same appearance, which contains above forty per cent. of antimonic acid. A tungstate of lead has lately been found at Zinnwalde, in Bohemia, and was first made known in England by Mr. Heuland. I have seen a specimen in his possession; it is somewhat similar to the acicular brown phosphate, but the crystals are parts of very acute square pyramids. (fig. 377.)

Frances. I do not suppose this is it; is it another ore of lead?

Mrs. L. Yes; it is a combination of lead and alumina; that is, an aluminate of lead, sometimes called plombgomme.

Except in its yellow colour, and less degree of transparency, it is a good deal like hyalite.

Mary. But this has a thin crust, nearly opake, and it is very heavy.

Mrs. L. I do not know the specific gravity of it: it is a

very scarce mineral, and found only at Huelgot, in Brittany. Of all the lead ores, galena is by far the most abundant; the lead smelted in Great Britain, which is chiefly obtained from it, varies from 45 to 48,000 tons annually.

Frances. What an immense quantity!

Mary. I cannot imagine how so much can be used every year.

Mrs. L. A great part of it is exported to China and to Holland; and, in England, it is principally used by the plumbers, or converted into red and white paint. But as much is smelted in Great Britain, as all the mines in the rest of Europe, produce.

	* Carbonate of lead.	† Earthy lead ore.	‡ Muriocarbonate.	* Phosphate of lead.	* Phosphate of lead.	§ Chromate of lead.	* Sulphate of lead.	‖ Molybdate of lead.	** Arsen. of lead.
Oxyde of lead . . .	82.	66.	85.	78.4	80.	64.	70.50	58.4	69.76
Oxyde of iron . . .	—	2.25	—	0.1	Trace.	—	—	3.08	—
Carbonic acid . . .	16.	12.	6.	—	—	—	—	—	—
Muriatic acid . . .	—	—	8.	1.7	1.62	—	—	—	1.58
Phosphoric acid . .	—	—	—	18.37	18.	—	—	—	—
Arsenic acid	—	—	—	—	—	—	—	—	26.40
Chromic acid . . .	—	—	—	—	—	36.	—	—	—
Molybdic acid . . .	—	—	—	—	—	—	—	37.	—
Sulphuric acid . . .	—	—	—	—	—	—	25.75	—	—
Silica	—	10.50	—	—	—	—	—	0.28	—
Alumina	—	4.75	—	—	—	—	—	—	—
Water	—	2.25	—	—	—	—	2.25	—	—
Loss	2.[illegible]	2.25	1.	1.43	0.38	—	1.50	1.24	2.26

* Klaproth. † John. ‡ Chenevix. § Thenard. ‖ Hatchett. ** Gregor.

CONVERSATION XVI.

FRANCES.

I HAVE been thinking of all the minerals we saw yesterday, and trying to recollect them; but there are so many ores of lead, that I feel quite puzzled about them.

Mrs. L. I should be much more surprised if you had remembered them all: but you will find it some assistance to your memory, to consult the table* I gave you of the different combinations of metals; and I would recommend you to go frequently to the British Museum, where you will see a large collection of fine minerals, systematically arranged and named.

There are but two metals whose ores you have not seen; antimony and arsenic: they are both found in a native state, as well as mineralized by other substances. This is native antimony from Andreasburg, in the Hartz.

Mary. I think it is whiter than most of the native metals.

Mrs. L. Yes, it is nearly silver white; and the foliated surfaces of the fracture are larger than in many ores that have the same kind of structure: it has ten cleavages, which are parallel to the faces of an octahedron and the rhombohedron; it is soft, and easily broken, and the specific gravity is about 6.7.

Frances. Is it found in sufficient quantity to work as an ore of antimony?

* Page 209, 210; see also the tabular system at the end of the volume.

Mrs. L. No; it has been found in several of the mining districts of the Continent, but very sparingly. The sulphurets are the most abundant of its ores.

Mary. How very much these are like the specimens of gray manganese ore.

Mrs. L. The radiated varieties, certainly, have a great deal of resemblance; but the colour of gray manganese ore is generally deeper than that of sulphuret of antimony; and, perhaps you recollect an experiment I told you of, which would immediately decide the question.

Frances. Yes; if I melt a little manganese ore with borax, I shall get a purple glass.

Mrs. L. And you may remember that before the blowpipe, antimony evaporates in the form of a gray vapour. The compact sulphuret is very nearly of the same colour as the compact galena; but its specific gravity is not above 4.4; that of the foliated variety is about the same, but the colour is rather lighter.

Mary. What is this, Mrs. L.? it appears of all colours, and quite brilliant.

Mrs. L. It is the radiated gray antimony with an iridescent tarnish, sometimes called peacock antimony ore; but the colour of the fracture is like that of the other kinds; it is found in several places in Germany and France; but antimony ores are very scarce in Great Britain.

Frances. In what part of England is it met with?

Mrs. L. In Cornwall, at St. Stephen's, and in Huel Boys mine, near Padstow; and in Scotland, at Glendinning, in Dumfriesshire.

The most uncommon variety is the plumose sulphuret of antimony. Here is a specimen intermixed with very small quartz crystals.

Mary. How curious that is! it looks like down.

Frances. And it feels quite soft.

Mrs. L. It consists of very delicate capillary crystals. I dare say you will find some on your finger after touching it.

Frances. Yes, here are a few, like hairs.

Mary. The radiated specimens are crystallized, and they seem to me very much like those of gray manganese. (figs. 378, 379, 380.)

Mrs. L. In general form they are; but, if you compare

the terminations, you will see the difference. Haüy supposes the primitive to be an oblique rhomboidal octahedron, but the only decided cleavage is parallel to the axis of the prism.

These minerals are, in general found in veins that contain galena, blende, and iron and copper pyrites; and sometimes with gold and silver ores. Another species, containing above 23 per cent. of nickel is occasionally found at Freussberg in Nassau. In colour and texture it is very much like the compact gray ore; but it is brittle and rather harder.

Frances. Are there any oxydes of antimony?

Mrs. L. Yes; here is the white oxyde in detached crystalline fragments.

Mary. It is very translucent, and appears to have *one* distinct cleavage.

Mrs. L. Yes; parallel to one side of the rectangular prism: it is very uncommon to find any regular terminations; so that these fragments can hardly be termed crystals. It has rather a pearly lustre, and sometimes occurs in tufts of acicular crystals. The red oxyde contains sulphur.

Frances. Surely I have seen some ore very much like this; both in colour and form.

Mrs. L. Yes, the radiated arseniate of cobalt; but this has, generally, more lustre: the specific gravity is about 4.

Mary. What colour do you call it?

Mrs. L. Cherry-red—the white mineral, associated with it, is carbonate of lime; one variety of this has been called tinder ore.

Frances. Why? will it take fire as tinder does, from a spark?

Mrs. L. No, it is so called from its texture; it occurs in these soft leaves, like felt; they are composed of extremely delicate fibres, interlaced, and are flexible; the colour is dark reddish brown. This differs also from the crystallized variety, in containing a good deal of silver; so that at Clausthal in the Hartz, it is worked as a silver ore. There is still another oxyde of antimony which is an ochry mineral of a straw colour. It may be distinguished from the yellow oxydes of several other minerals, by its evaporating before the blowpipe without melting.

Mary. Are there any more ores of antimony?

Mrs. L. No; it has not been found in combination with any of the mineral acids—neither has arsenic; its ores are nearly the same as those of antimony.

Frances. They will be easily distinguished from other minerals, by the blowpipe.

Mrs. L. Yes; the arsenical fumes arise almost immediately, on the application of heat, very copiously. The colour of native arsenic, when fresh broken, is pale lead gray; but you see how much darker this has become by exposure to the air. It does not crystallize, but frequently has pyramidal and cubical impressions.

Mary. The form is like that of malachite; large botryoidal.

Mrs. L. Yes, the concentric concretions are sometimes very distinct: when it is struck by a piece of metal, it has a peculiar sound; you may try it with a key.

Frances. It has a slight ringing sound—very slight.

Mary. What is the specific gravity of it?

Mrs. L. About 5.7, so that it cannot be pure.* Pure sulphuret of arsenic is a beautiful substance; there are two varieties of it, called red and yellow orpiment.

Frances. I think this is exactly like the colour of chromate of lead.

Mrs. L. It is aurora red, but darker than chromate of lead, and sometimes approaching to a crimson. Here are some tolerably perfect crystals, and very translucent, (figs. 382, 383.)

Mary. They seem to be four-sided prisms, variously modified.

Mrs. L. They are supposed to be derived from an octahedron, with isoceles triangular faces; (fig. 381.) but as there is no cleavage to direct us, this is at present, conjectural.

Frances. But these yellow specimens appear to have a very distinct cleavage.

Mrs. L. Yes, in one direction; but it does not crystallize: the colour is extremely rich and beautiful, and it has a good deal of resemblance to talc: but yellow orpiment is

* The specific gravity of pure arsenic, is 8.31,

seldom so translucent and lamellar as this; it is more frequently earthy and opake.

Mary. I think I have heard of orpiment; is any use made of it?

Mrs. L. Yes, king's yellow is made from it; and from the red variety (which is called realgar,) a fine colour is prepared; but they are often intermixed, as in these specimens.

Frances. In what part of the world is it found?

Mrs. L. The finest crystals of realgar are got in Bohemia, and in the dolomite of Mont St. Gothard; and it is found abundantly in Saxony and the Hartz; the yellow orpiment occurs in the Hartz and several parts of Germany, but not abundantly in the localities of realgar. Their specific gravity is not above 3.4; the other sulphuret, arsenical pyrites, contains from 30 to 40 per cent. of iron. It is a little like iron pyrites, when it is not distinctly crystallized.

Mary. This seems to be intermixed with several other minerals.

Mrs. L. Yes, you will find there, carbonate of iron, black blende, and quartz; and on this specimen purple fluor, quartz, and gray copper ore. Here are some fine crystals, (figs. 385, 386.) detached.

Frances. Those are very perfect and regular, but what do you think they were originally imbedded in?

Mrs. L. Probably clay-slate—the faces of the crystals are sometimes very much curved; the colour of the fresh fracture is quite white, but the surface of the crystals has a yellowish tarnish. When it is rubbed or heated, you may perceive the smell of arsenic. It is very abundant in most copper and tin mines.

Mary. Is arsenic ever obtained from it?

Mrs. L. Yes, white oxyde of arsenic, and artificial orpiment are prepared from it. These acicular crystals contain a portion of silver; the quantity varies from 1 to 15 per cent., and it is worked as a silver ore.

Frances. I suppose this is not so abundant as the other kind?

Mrs. L. No; it has only been found in Saxony, Salzburg, and Chili. Here is a radiated variety in carbonate of lime.

The last ore is the natural oxyde of arsenic: some of it is very much like pharmacolite.

Mary. I forget what that is. Has it another name?

Mrs. L. Arseniate of lime: but this is easily distinguished, from it being soluble in water; and sometimes it occurs in capillary crystals, so delicate, that the little tufts resemble those which appear on mouldy substances.

Frances. Here is a greenish earthy mineral; is it oxyde of arsenic?

Mrs L. Yes; it is a variety found at Nertschinsk, in Siberia, containing pale-coloured beryls, imbedded it: but this is not common.

Mary. And are there no more ores to see.

Mrs. L. No; but there is another class of minerals, which you have, perhaps, forgotten.

Frances. The inflammables? Oh, no! I have not forgotten them, for I have been anxiously wishing to see the crystallized diamonds.

Mrs. L. Well, I hope you will not be disappointed in them; but to persons who neither understand mineralogy nor crystallography, they must appear insignificant or worthless; and some of the most curious crystals are the smallest.

Mary. Are the primitive crystals scarce?

Mrs. L. They are not often found entirely free from modifications. Here is one, quite perfect, (fig. 389.) You had better have a magnifier.

Frances. The edges are quite sharp, and it is very bright.

Mrs. L. Some of them are rough, and nearly dull, externally.

Mary. How curious this is, Mrs. L.! (fig. 390.) It is like the model you showed us of a rhomboidal dodecahedron, arising from an octahedron.

Mrs. L. It exhibits the laminæ of superposition, very well. The most common forms of the diamond are these, (figs. 392, 393.)

Frances. How very convex the faces of some, are.

Mrs. L. Yes; there is a great tendency to convexity in most crystallizations of the diamond. The edges of the octahedron are seldom truncated by a single plane, as in this (fig. 391,) but in general, by two narrow convex surfaces, (fig. 392.) Cubes may be reckoned among its least

common forms: they are always dull, and mostly, dark coloured. If you look obliquely on this, you will see the glisten of the laminæ parallel to the primitive faces: these are macles (figs. 396, 397.) of octahedrons, modified by a flat pyramid on each face, and of dodecahedrons, with divided faces.

Mary. The re-entering angles are not visible in these macles.

Mrs. L. That is partly owing to the convexity of the faces. Here is a diamond almost spherical.

Frances. Is that a crystal?

Mrs. L. No; it seems to be the result of a confused crystallization, which produces a sort of radiated structure. The round diamonds will not yield to cleavage, like the crystalline ones, and are so hard, (on this account,) that they cannot be rubbed down in the usual way; so that they are only fit to break up for diamond powder, with those which are of a bad colour, or full of flaws.

Mary. Scarcely any of these are quite colourless: they have a greenish or brownish tinge.

Mrs. L. Colourless diamonds are much less common than you perhaps imagine, from knowing them to be principally used in jewellery. The rarest colours are blue, pink, and dark brown: but yellow diamonds, when the colour is clear, and equal throughout, are very beautiful, and much valued. I never saw one perfectly black or opake.

Frances. And you have not a blue one?

Mrs. L. I have one with a faint tinge. I never heard of any deep blue diamonds, except a small one that was in the collection of the late Mr. Greville*, and the large one in the possession of Mr. Eliason, which you have probably heard of.

Mary. Yes; I have been told it is worth 30,000*l*.

Mrs. L. Probably it is: diamonds of such uncommon size, and rarity of colour, cannot be valued by the rules which apply to common cases. The large diamond in the sceptre of the Emperor of Russia, was purchased by the

* Before this collection was purchased by the British Museum, most of the cut precious stones were disposed of.

Empress Catharine, for about 90,000*l.* ready money, and an annuity of 4,000*l.* more.

Frances. What a sum of money for a little stone! for I suppose it is not very large, except as it is a precious stone.

Mrs. L. It is about the size of a pigeon's egg, and weighs a hundred and ninety-three carats. (A carat is equal to three grains and two-fifths, troy weight.)

But the largest diamond hitherto found, is in the possession of the Rajah of Mattan, in the island of Borneo, where it was found about 80 years since: it weighs 367 carats.

Many years ago, the Governor of Batavia tried to purchase it, and offered in exchange 150,000 dollars, two large brigs of war, with their guns and ammunition, and other cannon, with powder and shot. But the Rajah refused to part with a jewel, to which the Maylays attach miraculous powers, and which they imagine to be connected with the fate of his family.

Mary. I never heard of this diamond before;* is it cut?

Mrs. L. I believe not; it is described as having the shape of an egg, with an indentation near the smaller end. The art of cutting and polishing was unknown in Europe till the fifteenth century: before that time, rough ones were set as ornaments. Among the diamonds in the British Museum, there is a very ancient gold ring (I believe, Roman,) in which an octahedral diamond is set; and the four diamonds which ornament the clasp of Charlemagne's mantle are natural crystals. This clasp is still preserved in Paris.

Frances. I suppose they were valued for their rarity formerly; I remember the ring, and do not think it a very elegant ornament.

Mrs. L. It is probable that they were also valued on account of their hardness, which you know is far greater than that of any other substance; for this reason, though it is expensive, it is considered as more economical than emery, or any thing else, for cutting and polishing hard stones.

* It is mentioned in the Memoirs of the Batavian Society.

Frances. Are diamonds used for any other purposes?

Mrs. L. Yes, a great many are employed by the glaziers, who cut out glass with them, for window panes; they are set in a steel socket, and attached to a wooden handle, about the size of a thick pencil. It is very remarkable, that they can only use the point of a natural crystal for this purpose; cut or split diamonds will not cut glass properly; they scratch it, but the glass will not break along the scratch, as it does when a natural crystal is used.

An application of the diamond, of great importance in the art of engraving, has been also made within a few years by Mr. Lowry, the first inventor of the mechanical methods now used in that part of the process, called etching.

Mary. In what way could they be made useful?

Mrs. L. For drawing or ruling lines, afterwards to be deepened by aqua-fortis. Formerly, steel points were used for this purpose; but they so soon become blunt by the friction against the copper, that it has always been impracticable to make what are called flat, or even tints with them; such as the azure parts of skies, large architectural subjects, and the sea in maps; but the diamond being turned to a conical point, or otherwise cut to a proper form, is not worn away by the friction of the copper, and, consequently, the lines drawn by it, are all of equal thickness.

Frances. That appears to me a very great improvement: but I suppose it is very difficult to turn the diamonds for this purpose?

Mrs. L. There are very few persons who understand well how to make diamond points. They are turned in a lathe, by holding a thin splinter of diamond against them, as a chisel.

Mary. And are not diamonds sometimes used in the works of watches?

Mrs. L. Yes.

Frances. But will you tell me how diamonds were first discovered to be carbon?

Mrs. L. Yes; but when I first mentioned it to you, I should have found it difficult to make you understand me. When a diamond is exposed to a heat, rather less than is necessary to melt silver, it is gradually dissipated; and it

is found to combine in the same proportion with the oxygen of the atmosphere, as charcoal, when it is burnt. This experiment has been frequently repeated, and always with the same result. It was conjectured to be an inflammable substance, as long ago as in 1609;* and in 1694, and the following year, they were burnt in the presence of the grand duke of Tuscany, by means of a strong lens, or burning glass. Sir Isaac Newton does not appear to have been acquainted with these experiments, but he suspected that it might be combustible, from its very great refracting power.

Mary. Why so?

Mrs. L. Because it is, in this respect, very analogous to amber; which, as well as other vegetable resins, is high-inflammable. Dr. Brewster has confirmed the relation, which Sir Isaac Newton supposed to exist, between the refractive power and inflammability of substances, by his experiments on phosphorus and sulphur; and his investigation of the properties of the diamond, have led him to conclude, "that it has originated, like amber, from, perhaps, vegetable matter, which gradually acquire a crystalline form by the influence of time, and the slow action of corpuscular forces."†

The specific gravity of the diamond, is not quite 3.5‡

Mary. Is it true that diamonds will shine in the dark?

Mrs. L. I do not know; I have never met with any that have that phosphorescent property. There are many substances prepared artificially, which will absorb the sun's rays when exposed to them, and afterwards emit light when in a dark place; and it has frequently been affirmed that diamonds have the same power.

You may observe that all these diamonds are detached, and crystallized on every side.

Frances. Yes; have you none in the rock they are found in?

Mrs. L. No; they are generally found loose in the beds

* Boetius de Boot.

† Edinburgh Philosophical Journal, vol. iii. p. 98.

‡ Some authors have given it a specific gravity as high as 3.55, and 3.6; their error should, probably, be ascribed to the want of a sufficiently correct instrument.

of streams: a diamond imbedded in the coarse conglomerate which occurs in the diamond district of Golconda, is a very rare specimen. I have seen one, which is in the fine collection of Mr. Heuland, and there are two or three more in England: the conglomerate consists of quartz pebbles and ochry earth. You will find an excellent account of the method of seeking diamonds, in Mr. Mawe's Travels in the Brazils: it is a very entertaining work, and particularly interesting, as Mr. Mawe is, I believe, the only Englishmen who has been permitted to see the Brazilian diamond mines, or (consequently) able to give a correct account of them.

No other minerals are arranged in the same family with the diamond; but the next contains three substances which consist principally of carbon.

Mary. This is exactly like a piece of charcoal.

Mrs. L. It is called mineral charcoal, and has the same properties, as that obtained by burning wood. It is found in thin layers, between the strata or beds of different kinds of coal, but not abundantly. Graphite or plumbago, you have seen.

Frances. Yes; in pencils. But why is it called black lead?

Mrs. L. Most likely, because plummets, which are thin cylinders of lead, were originally used for drawing on paper; and when this substance was applied to the same purpose, and was found to leave a much darker trace, it was distinguished by that circumstance, without any regard being paid to the difference of its composition. It occurs naturally in large roundish masses, imbedded in different kinds of rock. The most extensive mine of it in the world, is, at present, that at Borrodale, in Cumberland.

Mary. Is it useful for any thing besides making pencils?

Mrs. L. Yes; crucibles and furnaces for chemical operations are made of it, which resist a great degree of heat; and, in a state of powder, it is used for brightening grates, and for diminishing the friction of machinery.

Frances. It has quite a metallic lustre.

Mrs. L. Yes; particularly the scaly variety. Anthracite differs from it a good deal in external appearance, but the lustre is semi-metallic.

Mary. Yes; but the fracture of this is conchoidal, while that of graphite is granular and uneven: this is full of cracks, and looks as if it would fall to pieces.

Mrs. L. Sometimes it is slaty, and more seldom, columnar. Its specific gravity is between 1.4 and 1.8; that of graphite is about 2.

Frances. What is the difference between this and the coal we generally burn?

Mrs. L. The coal we are accustomed to use, contains between 30 and 40 per cent. of bituminous matter, which produces the peculiar odour you smell when it is burnt. But anthracite (or glance coal) burns, like charcoal, without a flame, and with scarcely any smell; and, on this account, it is called blind coal in some parts of Scotland. The next family is much more extensive; it includes all those minerals which contain, *essentially*, a considerable portion of bitumen, and the mineral oils.

Mary. Mineral oils! What are they like?

Mrs. L. There are two kinds, naphtha and petroleum: I have them both in phials.

Frances. What is this yellowish limpid fluid?

Mrs. L. That is naphtha;—smell it.

Frances. It has rather a pleasant smell.

Mary. And not like any thing else, I think.

Mrs. L. There is a liquid distilled from coal, and used for lighting a part of the lamps in London, which scarcely differs in any degree from naphtha.

Frances. How is this found, Mrs. L., in streams, or pits, or wells?

Mrs. L. Generally oozing from the rocks, or floating on the surface of streams of water. In Persia, on the border of the Caspian Sea, there are districts where the soil is so impregnated with naphtha, that if a few inches of the surface be scraped of, and a light applied, it takes fire immediately, and can only be extinguished by preventing the access of air. The ancient Persians, who were fire-worshippers, considered it as sacred fire, and built temples where it issued from the ground, and kept it constantly burning.

Mary. Are any of these temples in existence now?

Mrs. L. Yes: there is a large one at Badku, or rather a collection of many small cells, surrounding an open area,

each of which is inhabited by a priest, who watches over the fire: about a mile and a half distant, there are wells from which the naphtha is collected; and sometimes it rises to the surface of the earth, takes fire spontaneously, and flows, like a blazing torrent, to a great distance over the Caspian Sea.

Frances. It must be a magnificent sight; but, I suppose, almost as destructive as the eruption of a volcano.

Mrs. L. No; the naphtha, when burning in the open air, is dissipated so fast, that the flame has very little heat; but when it is lighted by means of a tube (such as a piece of a reed) inserted in the ground, it is sufficiently hot for culinary purposes. It is found also in Japan, and many European nations. In Japan and Italy the lamps are lighted with naphtha.

Petroleum, sometimes called black naphtha, occurs in different parts of England, particularly in Shropshire, where it issues from a limestone rock.

Mary. What is the difference between this and naphtha?

Mrs. L. It appears to be a mixture of naphtha, with bitumen, which renders it more viscid than the other kind. It is generally found where coal is abundant. In the kingdom of Ava, there is a stratum of coal, which yields an immense quantity of petroleum; at Rangoon, and about four or five miles distant, above five hundred small pits, or shafts, are sunk through earth, sandstone, and clay, till they reach the coal; through these shafts, it is drawn up in jars; and as soon as one is exhausted, they sink another.

Frances. Is it used for the same purpose as the naptha?

Mrs. L. No; it is too thick for burning in lamps; it is mixed with sand or earth, and made into cakes for fuel; but its principal use is to supply the place of tar, in covering boats and the roofs of houses.* The petroleum of Rangoon is of a greenish colour; that of Shropshire is blackish brown.

Of bitumen, or mineral pitch, there are three varieties: this is quite soft and elastic.

Mary. So it is; it is something like Indian rubber, when it has been made warm.

* For a more particular account of these pits, see Edinburgh Philosophical Journal, vol. v. p. 27, or Symes' Embassy to Ava.

Mrs. L. It is curious that it will take up a pencil mark in the manner of Indian rubber; but it leaves a soil, itself, upon the paper.

Frances. Are the little black globules on this specimen, the same substance?

Mrs. L. Yes; that is a petrified shell from Derbyshire; and the bitumen is supposed to be produced from the animal that once inhabited it. The harder kind of bitumen is called asphaltum, a name derived from the lake Asphaltites in Judea, (now the Dead Sea) where it is found in abundance, floating on the surface. The fracture of this kind is perfect and large conchoidal; and the lustre, resinous.

Mary. Will these minerals burn in the candle?

Mrs. L. Yes, readily;—you may try this one.

Mary. Oh, yes! how bright the flame is!

Frances. The heat seems to melt it.

Mrs. L. Yes; it melts quickly when exposed to heat, and the ancients employed it in a liquid state instead of mortar. The bricks of the walls of Babylon were cemented with hot bitumen.

Mary. And is it of any use in England?

Mrs. L. Yes; a great quantity is used for making the black varnish, commonly called japan.

Bitumen, when much intermixed with earthy matter, was formerly called maltha: sometimes it contains so much earth or sand as to be rather heavy. The specific gravity of it depends on its purity; that of asphaltum varies from rather less than 1. to 1.6 Petroleum thickens and becomes like bitumen by exposure to the air.

Frances. These are very curious substances. I had no idea there were such things in nature:—are the minerals in the next drawer, coal?

Mrs. L. Yes; there are a great many varieties of it, but the principal divisions are black and brown coal.

Mary. That we commonly use, is black coal, I suppose?

Mrs. L. Yes; it is also called slate coal from its structure: you know it splits much more readily in one direction than any other.

Frances. Yes, I have remarked that when the coal begins to be warm, a very slight force will split it.

Mrs. L. I dare say you have often seen pyrites in the coal; it is the cause of most of the explosions you so frequently hear in the fire.

Frances. Oh, yes! and I have been told by persons, who certainly believed it themselves, that it is gold.

Mrs. L. Gold has never been found in coal mines, and I think it is pretty certain that it never will be found in such a situation. Here is a specimen of common coal, with beautiful iridescent colours on the surface.

Mary. That is a very pretty specimen, but I suppose it is a rare variety?

Mrs. L. No; I dare say, if you like to take the trouble of mineralizing in the coal cellar, you may find some similar pieces.

Frances. Is not this jet, Mrs. L.?

Mrs. L. No; it is cannel coal; called, in some parts of Scotland, parrot coal.

Mary. How very compact it is; and it does not soil my fingers as the common coal does.

Mrs. L. No; it resembles jet very much; but the fracture has less lustre, and the colour is not so perfectly black. As it takes a gretty good polish, snuff-boxes, and ink-stands, and even necklaces are often made of it; but jet is much more extensively used for ornamental purposes. In the district of Aude, in France, twelve hundred men are employed in turning and cutting jet, into buttons, necklaces, ear-rings, rosaries, and drinking vessels. It is said, that about 100,000 weight of it is yearly expended for these purposes.

Frances. Is it possible, so much can be used every year?

Mrs. L. Perhaps so; a great part of it is exported to Spain. Jet is found in considerable abundance in the Prussian amber mines, and the miners call it black amber; sometimes pieces of amber are found enclosed in it. There are a few other carbonaceous minerals occasionally found in beds of coal, which are considered as varieties of black coal; but they are of very little consequence. One kind is called, from its texture, soot coal.

Mary. Is this it?

Mrs. L. Yes; it is quite earthy in some parts, and soils very strongly. The coal used in London, is chiefly brought

from Newcastle, but great quantities are raised in other parts of England. The same bed which is worked at Newcastle, extends through Durham, Yorkshire, and Derbyshire, and terminates in Nottinghamshire. Great abundance of coal is found at Whitehaven, in Cumberland; and, again, in the forest of Dean in Gloucestershire, and in Shropshire, besides other detached patches of coal, in different countries. These are technically termed coal-fields.

Frances. Is the coal always obtained by means of pits? or are there mountains of coal?

Mrs. L. No; there are no mountains of coal: the beds, or strata of coal, are thin, in comparison with those which occur between and above them. The coal field of Northumberland consists of a series of beds, amounting to 229.

Mary. What an expense it must be to work through so much useless stone.

Mrs. L. It is not *all* useless; some of the sand-stones are applied to different purposes.

Frances. But is not coal found in other countries?

Mrs. L. Yes; it is plentiful in many parts of Germany, in France, and in North America; but it is more extensively used in England than any other country, because we have now no forests to supply us with wood at a smaller expense.

Brown coal is bituminized wood, and several varieties are found in England.

Mary. This, I suppose, you call fibrous; it shows the woody structure remarkably well.

Mrs. L. Yes; that is from Bovey Tracey, in Devonshire, where the conchoidal variety is also found; they only differ in their degree of compactness.

Frances. And are they used for fuel?

Mrs. L. Yes they answer very well where a great heat is not required; they burn with a clear flame and bituminous smell, quite different from that of black coal, and, I think, much pleasanter. A great deal of the fibrous kind is found in Iceland, where it is called surturbrand. Formerly, whole trees were dug up, impregnated with bitumen, of which, the Icelanders made tables, and such furniture as did not require to be made of small parts. Another mineral having the properties of bituminous wood,

but of a coarse texture, and nearly black, is sometimes found in beds of the fibrous kind, particularly in Bohemia; it is called moor-coal.

Mary. Is not the mellite found on a substance like this?

Mrs. L. Yes; and amber sometimes; but that belongs to the next family, which contains mineral resins. Amber is a substance you have often seen.

Frances. Yes; but not any like this.

Mrs. L. The transparent yellow amber is the most admired, and therefore the most used. But the opake variety, of a yellowish white colour, is not uncommon. Sometimes the colour approaches to hyacinth red.

Mary. Have you no specimens of amber, containing insects?

Mrs. L. No; it is a common belief, that amber frequently contains insects; but the fact is, that all those specimens enclosing insects, that are sold under the name of amber, are a kind of gum, which is easily dissolved or softened, in many liquids; and the insects are introduced, before it becomes hard again.

Frances. But is not amber a kind of gum?

Mrs. L. It is probable, for many reasons, that it had a vegetable origin; but it is never found adhering to, or exuding from, living trees, in the manner of other gums.

The Prussian amber mines are worked in a stratum of trees, partly decomposed, and impregnated with pyrites; partly converted into jet and amber: and stalactites of amber are sometimes found depending from the branches. I mentioned to you, that amber, as well as several kinds of gum, was very similar to the diamond in its effects on light.

Mary. Is amber, then, chiefly composed of carbon?

Mrs. L. Yes; it burns with a bright flame, and a great deal of smoke, which has a pleasant arometic smell. A mineral resin was discovered, a few years ago, in digging Highgate tunnel, which was called fossil-copal. Here is a little of it, with some of the blue clay it was imbedded in.

Frances. And will this burn?

Mrs. L. Yes, nearly like amber. In was named from its resemblance to gum copal.

The last species is retin asphalt; an opake resinous mineral, which occurs in the bituminous wood at Bovey Tracey.

Mary. It is very light, but it has not much resemblance to resin.

Mrs. L. It appears by analysis, to consist of a mixture of resin and asphaltum, with about three per cent. of earth. It is found adhering to the brown coal, in irregular lumps, generally of a light brown colour; the fracture is imperfectly conchoidal, without any lustre. All the minerals of this family may be easily known by their aromatic smell when burnt; and their very low specific gravity, which is scarcely more than that of water.

Frances. Are they, like amber, rendered electric by friction?

Mrs. L. I have never been able to render any of these specimens of retin asphalt or fossil copal, electric by friction; the white amber is very weakly so, and, in some pieces, this property cannot be excited at all; particularly this kind, which is quite opake, and not unlike meerschaum. These are specimens of native sulphur.

Mary. I had no idea that sulphur was ever so transparent: these crystals are beautiful.

Mrs. L. They are from Spain: there are extensive mines of sulphur in Murcia and Arragon. The primitive crystal is an acute octahedron, of which the base is a rhombus (fig. 398.)

Frances. There are some small primitive crystals in the hollows of this specimen.

Mary. I see several modifications in these; some have their opposite edges truncated, and others, the summits (figs. 400, 401, 402.)

Mrs. L. The colour is always the same, but some crystals are less transparent than others: the fracture is imperfectly conchoidal and shining, or even splendent; the surface of the crystals is generally bright. When they are rubbed, they become like amber, negatively electric.

Frances. Is sulphur found in any part of England?

Mrs. L. No; but it occurs in Iceland, France, Switzerland, Transylvania, and Poland.

The other kind of sulphur is found only in volcanic countries.

Mary. Is it very different, in its appearance, from native sulphur?

Mrs. L. Yes; it generally has a cellular or corroded appearance, or forms thin crusts on lava. This is a specimen from Solfaterra, where there is an immense deposit of it, from which it is collected for commercial purposes.

Frances. Is it never crystallized?

Mrs. L. Sometimes you may observe tufts of crystals, but they are very minute. The colour of volcanic sulphur is frequently deep orange, and sometimes red, which is never the case with the other kind; and it is translucent or nearly opake. The crystallized sulphur refracts doubly, and is sometimes quite transparent.

This mineral, and those of the two last families, are considered to be of much more recent origin than the earthy substances of which the crust of the earth is chiefly composed, or the metallic ones that are found imbedded in them. Indeed, the formation of sulphur is still taking place in most volcanic countries. But the consideration of the different ages of minerals, belongs to geology.

Mary. I should be delighted to know something of it; for I have found mineralogy extremely entertaining; and I think geology cannot be less so.

Mrs. L. It is a very interesting study; but it cannot be pursued in the limited way in which a knowledge of mineralogy may be acquired; I mean by examining cabinet-specimens. An acquaintance with its principal features may be obtained from books: but in order to become a geologist, you must not only observe the different rocks and strata in various countries, but must also carefully compare those of the same kind occurring in different situations, or you will not be able to derive much advantage from books.

Frances. Do you think it would be of any use to me, if I were to write some account of all the minerals and rocks which I shall see in my excursion into Cornwall?

Mrs. L. I would advise you, my dear, to confine yourself at present to the examination of simple minerals, such as I have shown you. Many of the rocks are compounded of two, three, or even more, of these substances; and you do not know even their names. Yet, if you be anxious to study geology, you may find a great deal of useful infor-

mation in Mr. Phillip's "Outlines of the Geology of England and Wales." That work is an excellent and well arranged collection of geological facts; and Curvier's "Introduction to the Theory of the Earth," though it may be styled an elementary one, is truly scientific. To read either of these carefully, will, during your travels, sufficiently occupy your leisure; and, if, on your return, you feel inclined to pursue the study of geology, I will endeavour to assist you. I can lay before you an extensive collection of rock-specimens; and if you set any value on my instructions, those instructions shall be cheerfully imparted.

APPENDIX, No. I.

ACTINOTE, or Actinolite—ἀκτὶν (actin,) a ray; a radiated mineral.

Adularia—the mountain called Adula, on which it was supposed to have been first collected.

Agalmatolite—ἄγαλμα (algama,) a statue; because figures are carved in it.

Agaric mineral—the resemblance to a fungus, or agaric.

Alabaster—ἀλάβαστρον (alabastron,) a kind of marble, of which vases were made.

Agate—the river Achates, in Sicily, where it was first found.

Alalite—town of Ala, in the Alps, near which it was discovered.

Allochroite—ἄλλος (allŏs,) different, and χρόα (chrŏa) colour—it changes its colour before the blowpipe.

Allophane—ἄλλος, φαίνω; it resembles another mineral (carbonate of copper.)

Amethyst—ἀ, not, and μέθυστος (methystos,) drunk; because it was supposed to be an antidote to intoxication, by being worn.

Amianth—ἀμίαντος (amiantos,) unstained or destroyed.

Amphigene—αυφι, both, γένος, origin, its form originating from either of two solids, as a primitive.

Analcime—ἀνὰ (ana,) without, and ἀκλη (alkē,) force; it is very weakly electric.

Andalusite—from Andalusia, where it was first discovered.

Anhydrite—ἀνὰ (ana,) without, and ὕδωρ (hudōr,) water

or moistúre; a mineral which contains no water. Other substances are called anhydrous for this reason.

Anthophyllite—from the resemblance of its colour to that of the anthophyllum, a flower.

Apatite—ἀπατάω (apataō,) to deceive; because it resembles several minerals so much as to be sometimes mistaken for them.

Aphrite—ἀφρὸς (aphrōs,) froth.

Anatase—ἀνὰ (ana,) up, in height, and τάσις (tasis,) length, extension; from the form of its crystals.

Anthracite—ἄνθραξ (anthrax,) coal.

Apophyllite—ἀπὸ (apo,) from, and φυλλον (phūllon,) a leaf, from its foliated structure.

Aplome—ἁπλόος (haplöos,) simple—underived, because the primitive is uncertain.

Arendahlite—Arendahl, in Norway.

Arcticite—first found within the arctic circle.

Arragonite—Arragon, in Spain.

Asbestus—ἀ (a,) not, and σβέννυμι (sbennumi,) to extinguish. It cannot be burnt, and the ancients are supposed to have made the wicks of lamps of it.

Asphalt—from the lake Asphaltites.

Avanturine.—This name was first given to a glittering substance, by a French workman, who dropped some brass or copper filings into a vitreous mixture, in a state of fusion, *par avanture.* Mineralogists afterwards applied it to the variety of quartz, which resembles it.

Augite—αὐγη (augē,) splendour.

Barytes—βαρὺς, heavy.

Blende—from the German *blenden*, to dazzle or blind the eyes, when held in the sunshine; glistening.

Botryolite—βοτρὺς (botrus,) a cluster of grapes, and λίθος (lithos,) a stone.

Calamine—[Lat.] calamus, a reed; because, when it is melted, it adheres to the bars of the furnace, like reeds.

Calcedony—(more properly chalcedony) from χαλκηδὼν (chalkēdōn,) a city of Bythnia, in Asia Minor.

Carnelian—caro [Lat.] flesh; from its colour.

Cerite—Planet Ceres.

Ceylonite—Ceylon, whence it was first brought.

Chiastolite—from its having the mark of the Greek letter X (chi.)

Chlorite—χλωρὸς (chlōros,) green.

Chlorophane—χλωρὸς (chlōros,) green, and φαίνω (phainō,) to appear, or shine: it acquires this colour by being heated.

Chrome—χρῶμα (chrōma,) colour; it received this name from its imparting colour to the minerals which contain it.

Cimolite—the Isle of Cimolia, now Argentiers.

Cinnabar—κινναβαρι (kinnabari,) red-coloured grain.

Coccolite—κοκκὸς (kokkŏs,) grain; from its structure.

Colophonnite—from its resemblance to resin, anciently called *colophonia pix*, from the city of Golophon, in Asia Minor.

Cryolite—κρύος (kruŏs,) cold, and λίθος (lithos,) stone: it melts like ice, in the flame of a candle.

Cyanite—κύανος (kuanos,) blue colour.

Datholite—δαθολος (datholos,) turbid: the crystals are never transparent.

Diallage—διαλλαγη (diallagē,) difference. Haüy gave it this name from the difference of cleavage in this mineral and others, that were often confounded with it.

Diaspore—διασπορὰ (diaspōra,) dispersion; when it is exposed to the flame of a candle, it flies into minute splinters, and is dispersed.

Dichroite—δὶς (dis,) twice, and χρόα (chrŏa,) colour; on account of the two colours it exhibits when viewed in different directions.

Diopside—διόψις (diopsis,) transparency.

Dioptase—διοπτάσις (dioptăsis,) visible on looking through it; that is, the planes of cleavage, from the light they reflect.

Dypyre—δὶς (dis,) twice,—and πῦρ (pūr,) fire; from the double effect on it. This mineral melts and phosphoresces at the same time, before the blowpipe.

Disthene—δὶς (dis.) double,—and σθένος (sthenos,) force; it acquires both kinds of electricity by friction.

Dolomite—M. Dolomieu, a great geologist.

Elaolite—ἔλαιον (elaion,) oil; from its oily lustre.

Electrum—The Latin name for the same mixture of gold and silver.

Epidote—ἐπίδοσις (epidŏsis,) an addition.

Euclase—εὖ (eu,) easily, and κλάσις (klasis,) breaking; from its great frangibility.

Eudyalite—εὖ (eu,) easily, δύω (duō,) to vanish; from its dissolving easily in acids.

Eukairite—εὖ (eu,) fortunately, and καιρὸς (kairos,) an occasion; named by Berzelius, from its fortunately coming to his knowledge at the time he was finishing his investigation of the properties of Selenium; a metal it contains.

Felspar—derived from the German field, (a field) and spath (spar) a shining substance; in German, fieldspath; from its so frequently being a constituent of the loose blocks of stone (feldern) scattered over the country.

Fluor—Lat. fluo (to flow;) it was first used in Germany as a flux to reduce the metallic ores.

Gadolinite—Professor Gadolin, who analyzed it.

Garnet—Lat. granum (a seed.) The seed of the pomegranate, from its colour.

Glucine—γλυκὺς (sweet;) when dissolved in acids, it forms sweet salts.

Grammatite—γράμμα (gramma,) writing, marked by a line; in reference to its crystals.

Graphite—γράφω (graphō,) to draw; it is well known under the name of black-lead.

Grenatite—from its resemblance to garnet. (See *Garnet.*)

Grossular—groseille [Fr.,] a gooseberry; from its colour.

Gurhofite—so called from Gurhof, in Austria.

Gypsum—γυψόω (gūpsŏō,) to plaster or spread. From this mineral, plaster of Paris is manufactured.

Harmotome—ἁρμόζω (harmŏzō,) to fit in, and τέμνω (temno,) to cut; from the peculiar form of its crystals.

Hauyne—L'Abbè Haüy.

Heliotrope—ηλιος (hēlios,) the sun; and τρόπος (trŏpŏs,) a turning; according to Pliny, it was used for solar observations.

Helvine—ηλιος (hēlios,) the sun; from its yellow colour.

Hæmatite—αἷμα (haima,) blood; from its colour.

Hyalite—ὕαλος (hualŏs,) glass; from its glassy appearance.

Hydrophane—ὕδωρ (hūdōr,) water, and φαίνω (phainō,) to shine. By immersion in water, it acquires the property of reflecting brilliant colours.

Hypersthene—ὑπὲρ (huper,) exceeding, and σθένος (sthĕnŏs,) strength; from its remarkable tenacity.

Ichthyophthalmite—ἰχθὺς (ichthus,) a fish, and ὀφθαλμὸς (ophthalmos,) an eye; the lustre of this mineral resembling that of fish's eye.

Idocrase—εἶδος (eidos,) a form; and κρᾶσις (krasis,) a mixture; a mixed form.

Indianite—India; at present, its only locality.

Indicolite—so called from its dark blue colour.

Iolite—ἴον (ion,) or Lat. viola, a violet: from its colour.

Iridium—iris (Lat.,) the rainbow, from the variety of colours which its solutions exhibit.

Iserine—river Iser, near the Reisengeberge.

Jasper—ἴασπις (iaspis.)

Jenite—Jena.

Karpholite—κάρφος (karphos,) straw; from its colour.

Kyanite—κύανος (kuanos,) blue.

Latialite—Latium, where it was first found.

Laumonite—from Gillet Laumon, its discoverer.

Lepidolite—λεπὶς (lĕpĭs,) a scale, and λίθος (lithos,) a stone; from its structure.

Leucite—λευκὸς, (leukos,) white.

Lievrite—Le Lièvre, a mineralogist.

Lithomarge—λίθος (lithos,) a stone, and marga [Lat.,] marl.

Lucullite—black marble, which, according to Pliny, was named by the consul Lucullus, after himself.

Malachite—μαλάχη (malachē,) marsh-mallow; from the resemblance of their colour.

Meerschaum—meer, the sea, and schaum, froth, [Germ.] sea foam.

Meionite—μείων (meiōn,) inferior; from the lowness of its pyramid, compared with that of other crystals.

Melanite—μέλας (mĕlas,) black.

Menilite—Menil Montant, near Paris.

Menachanite—Valley of Menaccan in Cornwall.

Mesotype—μέσος (mĕsŏs,) middle, and τύπος (tŭpos,) a mark or form. Haüy considered its primitive form as being intermediate between those of analcime and stilbite.

Mica—mico [Lat.,] to glitter.

Miemite—Miemo, in Tuscany.

Moroxite—μόρον (mŏrŏn,) mulberry; from its colour.

Naphtha—νάφθα (naphtha) from ἀνάπτω (anaptō,) to inflame, to take fire.

Natron—desert of Nitron, where it was anciently collected.

Nacrite—Nacré, [Fr.] pearly.

Natrolite—from natron, which it contains.

Nepheline—νεφέλη (něpěhlē,) a cloud; it is not quite transparent.

Nigrine—niger [Lat.,] black.

Nickel—[German,] false. The first ore of nickel that was discovered, was thought to be copper ore; but as that metal could not be extracted from it, the miners called it kupfer-nickel, which means "false copper:" and Hierne, who first ascertained its nature, gave it this name.

Novaculite—a whetstone; from Novacula [Lat.] a knife.

Obsidian—Pliny gave this name to a black glassy mineral, which was found in Ethiopia, by Obsidius.

Octahedrite—ὀκτὼ (oktō,) eight, ἕδρα (hědra,) a side, from its form, an octahedron.

Olivine—olive colour.

Onyx—ὄνυξ (ŏnux,) a nail. It is described by the ancients, as having the form and colour of the white part of of the nail.

Paranthine—παρὰ, (para,) exposed, and ἄνθος (anthos,) a flower,; because it decays rapidly, when exposed to the weather, as a flower.

Opal—ὤψ (ōps,) an eye: it was believed by the ancients to have the power of strengthening the eye.

Orpiment—Auri pigmentum, [Lat.] gold paint; from its colour.

Palladium—The planet Pallas.

Peliom—πελιώμα (pěliōma,) blackish blue colour.

Petroleum—πέτρος (pětrŏs,) a rock, and ἔλαιον (elaion,) oil; mineral oil.

Pimelite—πιμελη (pimelē,) fat; it has a greasy feel.

Pinite—Pini gallery in the mines of Schneeberg.

Picrolite—πικρὸς (pikros,) bitter.

Pistacite—πιστάκια (pistakia,) the pistachio nut; from its colour.

Plasma—πλάσμα (plasma,) an engraving: it was used by the ancients to engrave heads on, &c., in the manner of other gems.

Platina—Plata [Spanish,] silver, a diminutive noun; probably, from its occurring in small grains.

Pleonaste—πλεοναστὸς (plěŏnastŏs,) abounding. Haüy

gave it this name, from the number of faces on some of the crystals, in which it principally differed from spinelle.

Plumbago—Plumpus [Lat.,] lead, and ago, to act; because it supplies the place of lead, in drawing.

Polyhallite—πολυς (pŏlus,) many, ἁλς (hals,) salt, and λιθος (lithŏs,) a stone. It is a combination of several salts.

Prehnite—Prehn, who discovered it.

Prase—πράσον (prasŏn,) a leek; from its colour.

Pumice—[Lat.] pumex.

Pycnite—πυκνὸς (pŭknŏs,) compact.

Pyroxene—πῦρ (pŭr,) fire, and ξένος (xĕnŏs,) a stranger; because, though it is found in lava, it was thought not to be a volcanic production.

Pyrites—πῦρ (pŭr,) fire, πυρίτης [Gr.] the stone itself emitting sparks, when struck.

Pyrote—πῦρ (pŭr,) fire, ὤψ (ōps,) appearance.

Pyrophysalite—πῦρ (fire,) φύσαλις (phusalis,) a bubbling, or ebullition, from the effect of the blowpipe on it.

Ruby—ruber, or rubieus [Lat.,] red, from its colour.

Rutile—rutilus [Lat.,] red.

Sahlite—Sahla in Sweden, where it was found.

Sapphire—σαπφειρος (sappheiros;) its ancient name.

Saussurite, so named from Saussure, the geologist.

Scapolite—σκαπτον (skapton,) a rod, from the form of its crystals.

Scheele, or Scheelium.—Werner gave this name to Tungsten, in honour of Scheele, who discovered the metal it contained.

Schillerspar—Schillern, [Germ.,] chatoyant.

Schorl—so called from the village of Schorlau.

Selenite—σελήνη (sēlĕnē,) the moon; from its silvery appearance.

Selenium (idem) indicating its relation to tellurium (which see.)

Serpentine—from its resemblance to the skin of a serpent, in colour and delineations.

Slickenside, or Sleek-inside—from its polished surface.

Smaragdite—Smaragdus, [Lat.,] an emerald, from its colour.

Sommite—so called from Monte Somma.

Sphene—σφὴν (sphēn,) a wedge, in reference to the form of its crystals.

Spodumen—σποδὸς (spŏdŏs,) ashes, and μένω (mĕnō,) to

remain. By the action of the blowpipe it is converted into scales, and afterwards into ashes.

Staurolite—σταυρὸς (staurŏs,) a cross; the crystals intersect each other, like a cross.

Steinheilite—first observed by Count Steinheil.

Stilbite—στιλβὸς (stilbŏs,) splendent.

Stilpnosiderite—στιλπνὸς (stilpnos,) shining, and σίδηρος (sidēros,) iron: an iron ore having considerable lustre.

Steatite—στεαρ (stĕar,) soap; it feels remarkably soapy.

Strontian—so called from a village of that name in Scotland.

Tellurium—Tellus, [Lat.] the earth; other metals having been named after the other plants.

Thallite—θαλλὸς (thallŏs,) the bud of the olive tree: from its colour.

Thumerstone—Thum, in Saxony.

Topaz—Τοπάζον (tŏpāzŏn,) an island in the Red Sea, where the ancients collected topazes; and which was so called from (the verb,) τοπάζω (tŏpazō,) to seek; because it was frequently concealed by fog, and difficult to find.

Tourmaline—probably derived from Tournamel, its Cingalese name.

Tremolite—so called from the valley of Tremola.

Triphane—τρεῖς (trēis,) three, and φαίνω (phainō,) to be apparent; it has three cleavages equally distinct.

Tripoli—from its locality.

Teleste—τελέσιος (tĕlĕsiŏs,) perfect; a name given by Haüy to sapphire, as being a more perfect or pure corundum.

Tungsten—this means "heavy stone," in the German language; so called from its great specific gravity.

Uranium—from the planet Uranus.

Wavellite—so called from Dr. Wavell, who analyzed it.

Witherite—named after Dr. Withering, who discovered this mineral at Anglesark, in Lancashire.

Wernerite—D'Andrada named it after the great mineralogist, Werner.

Wolfram—this mineral was originally mistaken for antimony, which was called *the wolf*, by the alchemists. Hence arose the term *spuma lupi* (foam of the wolf,) the word *ram* (signifying spuma) being applied by the Germans to many substances, having a laminated texture.

Yenite—named after the battle of Yena or Jena.

Yttria—this substance was first found at Ytterby in Sweden.

Zeolite—ζέω (zĕō,) to froth; in reference to the action of the blowpipe on it.

Zircon—an Indian word, signifying four-cornered, and applied to these crystals.

Zoisite—named after Baron Von Zois.

APPENDIX, No. II.

TABULAR VIEW

OF THE

ARRANGEMENT ADOPTED IN THIS WORK.

EARTHY CLASS.

ORDER I.—EARTHY MINERALS.

1st Genus.—(Siliceous.)

FLINT FAMILY.

1. Quartz.
   1. Amethyst.
   2. Rock crystal.
   3. Common quartz.
   4. Fat quartz.
   5. Sandstone.
   6. Rose quartz.
   7. Avanturine.
   8. Cats'-eye.
   9. Prase.
2. Iron-flint.
3. Hyalite.
4. Opal.
   1. Precious opal.
   2. Common opal.
   3. Semi-opal.
   4. Fire opal.
   5. Hydrophane.
   6. Cacholong.
   7. Wood opal.
5. Menilite.
   1. Brown.
   2. Gray.
6. Siliceous sinter.
   1. Common.
   2. Opaline.
   3. Pearly.
7. Flint.
8. Hornstone.
   1. Chonchoidal.
   2. Splintery.
   3. Woodstone.
9. Calcedony.
   1. Common.
   2. Carnelian.
   3. Plasma.
   4. Heliotrope.
   5. Chrysoprase.

10. Jasper.
    1. Egyptian.
    2. Common.
    3. Striped.
    4. Porcelain.
    5. Agate Jasper.
11. Agate.
12. Flinty slate.
    1. Common.
    2. Lydian-stone.

GARNET FAMILY.

1. Garnet.
    1. Precious.
    2. Common.
2. Topazolite.
3. Pyreneite.
4. Grossular.
5. Allochroite.
6. Colophonite.
7. Melanite.
8. Pyrope.
9. Aplome.
10. Leucite.

IDOCRASE FAMILY.

1. Idocrase.
2. Cinnamon-stone.
3. Gehlenite.
4. Scapolite.
    1. Radiated.
    2. Foliated.
    3. Compact.

SCHORL FAMILY.

1. Schorl.
    1. Precious (tourmaline.)
    2. Common.
2. Iolite.
    1. Steinheilite.
    2. Peliom.
3. Axinite.

EPIDOTE FAMILY.

1. Epidote.
    1. Common.
    2. Manganesian.
2. Zoisite.

PITCHSTONE FAMILY.

1. Obsidian.
2. Pitchstone.
3. Pearlstone.
4. Spherulite.
5. Pumice.
    1. Common.
    2. Glassy.

ZEOLITE FAMILY.

1. Karpholite.
2. Prehnite.
    1. Foliated.
    2. Radiated.
3. Sodalite.
4. Natrolite.
5. Skolezite.
6. Mesolite.
7. Thomsonite.
8. Stilbite.
9. Analcime.
10. Chabasite.
11. Harmotome.
12. Laumonite.
13. Dypyre.
14. Meionite.
15. Albite.

LAZULITE FAMILY.

1. Lapis lazuli.
2. Haüyne.

FELSPAR FAMILY.

1. Felspar.
    1. Adularia.
    2. Glassy felspar.
    3. Labrador felspar.
    4. Common felspar.

5. Disentegrated felspar.
6. Compact felspar.

2. Indianite.
3. Gieseckite.
4. Spodumene.
    1. Amblygonite.
    2. Killinite.
5. Elaolite.
6. Apophyllite.
7. Petalite.
8. Saussurite.

MICA FAMILY.

1. Lepidolite.
2. Mica.

SLATE FAMILY.

1. Clay slate.
2. Whet slate.
3. Alum slate.
4. Drawing slate.
5. Bituminous slate.
6. Adhesive slate.

CLAY FAMILY.

1. Porcelain clay.
2. Potters' clay.
3. Loam.
4. Claystone.
5. Variegated clay.
6. Slate clay.
7. Rottenstone.
8. Tripoli.
9. Polishing slate.
10. Kollyrite.

LITHOMARGE FAMILY.

1. Lithomarge.
    1. Indurated.
    2. Friable.
2. Pimelite.
3. Figurestone.
4. Mountain soap.
5. Bole.
6. Yellow earth.
7. Green earth
8. Fuller's earth.
9. Cimolite.
10. Lemnian earth.

HORNBLENDE FAMILY.

1. Hornblende.
    1. Common.
    2. Basaltic.
    3. Slaty.
2. Actinolite.
    1. Granular.
    2. Common.
    3. Glassy.
    4. Asbestus.
3. Tremolite.
    1. Common.
    2. Glassy.
    3. Asbestus.
    4. Compact.
4. Diallage.
    1. Smaragdite.
    2. Schillerspar.
5. Bronzite.
6. Anthophyllite
7. Hypersthène

AUGITE FAMILY.

1. Sahlite.
2. Augite.
    1. Common.
    2. Granular (coccolite.)
3. Pyrgomme, or Fassïte.
4. Diopside.
    1. Alalite
    2. Mussite.

2d Genus, (Magnesian.)

MAGNESIATE FAMILY.

1. Hydrate of magnesia.

1. Foliated.
2. Earthy.

TALC FAMILY.

1. Talc.
    1. Foliated (common)
    2. Indurated.
    3. Earthy.
2. Serpentine.
    1. Precious.
    2. Common.
3. Steatite.
4. Potstone.
5. Nephrite.
    1. Common.
    2. Axestone.
6. Chlorite.
    1. Foliated.
    2. Common.
    3. Slaty.
    4. Earthy.
7. Asbestus.
    1. Flexible. (Amianth.)
    2. Common.
    3. Ligniform.
    4. Rock cork.
    5. Rock leather.

CHRYSOLITE FAMILY.

1. Chrysolite.
2. Olivine.

3d Genus.—(Aluminous.)

RUBY FAMILY.

1. Corundum.
    1. Precious. (Sapphire.)
    2. Common.
    3. Splintery. } (Emery.)
    4. Granular. }
2. Chrysoberyl.
3. Spinel.
4. Ceylonite.
5. Automolite.
6. Andalusite.
7. Allophanite.

NEPHELINE FAMILY.

1. Nepheline.
2. Bucholzite.

TOPAZ FAMILY.

1. Topaz.
2. Pyrophysalite.
3. Pycnite.

CYANITE FAMILY.

1. Cyanite.
2. Rhætizite.
3. Blue spar.
4. Fibrolite.
5. Grenatite.
6. Pinite.

4th. Genus.—(Zirconia.)

ZIRCON FAMILY.

1. Zircon.
    1. Zirconite.
    2. Hyacinth.
2. Eudyalite.

5th Genus.—(Glucina.)

1. Emerald.
2. Beryl.
3. Euclase.

ORDER II.—ACIDIFEROUS EARTHY MINERALS.

1st *Genus.—Calcareous.*

FAMILY OF CARBONATES.

1. Slate-spar.
2. Aphrite.
3. Chalk.
4. Common limestone.
5. Roestone.
6. Calcspar.
7. Foliated granular limestone (marble.)
8. Fibrous limestone (satin-spar.)
9. Peastone.
10. Calc-tuff.
11. Stalactitic carbonate of lime, (calc-sinter.)
12. Blue Vesuvian limestone.
13. Lucullite.
    1. Compact.
    2. Foliated.
    3. Columnar. (Madreporite.)
14. Arragonite.
15. Dolomite.
    1. Dolomite spar.
    2. Common dolomite.
    3. Compact Dolomite.
16. Gurhofite.
17. Pearl-spar, or brown-spar.
18. Marl.
    1. Earthy.
    2. Indurated.
    3. Bituminous marl-slate.

FAMILY OF PHOSPHATES.

1. Apatite.
2. Phosphorite.

FAMILY OF FLUATES.

1. Fluor.
    1. Foliated.
    2. Fibrous.
    3. Earthy.
    4. Compact.

FAMILY OF SULPHATES.

1. Hydrous sulphate or gypsum.
    1. Foliated.
    2. Foliated-granular
    3. Fibrous.
    4. Earthy.
2. Anhydrous sulphate or anhydrite.
    1. Foliated.
    2. Foliated granular.
    3. Siliciferous.
3. Glauberite.
4. Polyhallite.

FAMILY OF BORO-SILICATES.

1. Datholite.
2. Botryolite.

FAMILY OF TUNGSTATES.

1. Tungstate of lime.

FAMILY OF ARSENIATES.

1. Pharmacolite.

FAMILY OF SILICATES.

1. Table-spar.

2d *Genus—(Aluminous.)*

FAMILY OF SULPHATES.

1. Alum.

2. Alumstone.
3. Aluminite.

FAMILY OF SULPHATES.

1. Wavellite.
2. Azurite.

FAMILY OF FLUATES.

1. Cryolite.

FAMILY OF MELLATES.

1. Mellite.

3d Genus.—(Magnesian.)

FAMILY OF CARBONATES.

1. Carbonate of Magnesia.
2. Meerschaum.

FAMILY OF SULPHATES.

1. Epsom salt.

FAMILY OF BORATES.

1. Boracite.

FAMILY OF SILICATES.

1. Lenzinite.

4th Genus.—(Barytic.)

FAMILY OF CARBONATES.

1. Carbonate of barytes or witherite.
    1. Crystallized.
    2. Compact.
    3. Earthy.

FAMILY OF SULPHATES.

1. Sulphate of barytes, or heavy spar.
    1. Foliated.
    2. Columnar.
    3. Radiated, or Bolognian spar.
    4. Granular.
    5. Earthy.
    6. Compact.

5th Genus.—(Strontian.)

FAMILY OF CARBONATES.

1. Strontianite.

FAMILY OF SULPHATES.

1. Sulphate of Strontian.
    1. Crystallized.
    2. Fibrous.

ALKALINE CLASS.

1st Genus.--(Salts of Potash.)

FAMILY OF NITRATES.

1. Nitrate of potash, (saltpetre.)

2d Genus.—(Salts of Soda.)

FAMILY OF CARBONATES.

1. Carbonate of soda.
    1. Common.
    2. Fibrous. (Trona.)

FAMILY OF SULPHATES.

1. Glauber salt.
2. Reussite.

FAMILY OF MURIATES.

1. Rock salt.
2. Lake salt.

FAMILY OF BORATES.

1. Borax.

3d *Genus.—Salts of. (Ammonia.)*

FAMILY OF SULPHATES.

1. Sulphate of ammonia.

FAMILY OF MURIATES.

1. Sal-ammoniac.

METALLIC CLASS.

1st *Genus.—(Gold.)*

FAMILY OF ALLOYS.

1. Native gold.
2. Brass-yellow native gold.
3. Electrum.

2d *Genus.—(Platinum.)*

1. Native platinum.

3d *Genus.—(Palladium.)*

1. Native palladium.

4th *Genus.—(Iridium.)*

1. Native iridium.

5th *Genus.—(Tellurium.)*

1. Native tellurium.
2. Graphic ore.
3. Yellow ore.
4. Black ore.

6th *Genus.—(Mercury.)*

FAMILY OF ALLOYS.

1. Native Mercury.
2. Amalgam.

FAMILY OF SULPHURETS.

1. Cinnabar.
    1. Crystallized.
    2. Pulverulent.
2. Hepatic ore.

FAMILY OF CHLORIDE.

1. Horn quicksilver.

7th *Genus.—(Silver.)*

FAMILY OF ALLOYS.

1. Native silver.
2. Auriferous silver.
3. Antimonial silver.
4. Arsenical silver.
5. Bismuthic silver.
6. Eukairite.

FAMILY OF SULPHURETS.

1. Silver glance.
2. Antimonial silver-glance.
3. Cupriferous silver-glance.
4. White silver-ore.

FAMILY OF OXYDES.

1. Red silver-ore.
    1. Dark red silver-ore.
    2. Light red silver-ore.

FAMILY OF CHLORIDES.

1. Corneous silver-ore.

FAMILY OF SALTS.

1. Carbonate of silver.

8th Genus.—(Copper.)

FAMILY OF ALLOYS.

1. Native copper.

FAMILY OF SULPHURETS.

1. Copper-glance.
   1. Compact.
   2. Foliated.
   3. Malleable.
2. Variegated copper-ore.
3. Copper pyrites.
4. Gray copper ore.
5. Tennantite.
6. Black copper-ore.

FAMILY OF OXYDES.

1. Red oxyde.
   1. Crystallized.
   2. Ferruginous—(Tile-ore.)
2. Black oxyde.
3. Hydrate.
   1. Velvet copper ore.

FAMILY OF SALTS.

1. Carbonate.
   1. Malachite.
      1. Compact.
      2. Fibrous.
   2. Blue carbonate.
2. Anhydrous carbonate.
3. Chrysocoll — (subcarbonate.)
4. Silicate—(Dioptase.)
5. Carbosilcate.
6. Arseniate.
   1. Lenticular.
   2. Foliated.
   3. Trihedral.
   4. Oliven ore.
   5. Fibrous.
   6. Ferruginous.
7. Muriate.
8. Phosphate.
9. Sulphate.

9th Genus.—(Iron.)

FAMILY OF ALLOYS.

1. Native iron.

FAMILY OF SULPHURETS.

1. Magnetic pyrites.
2. Common pyrites.
   1. Crystallized.
   2. Radiated.

FAMILY OF OXYDES.

1. Magnetic iron-ore.
   1. Crystallized.
   2. Granular.
   3. Arenaceous. (Iron-sand.)
2. Iron-glance.
   1. Common.
   2. Micaceous.
3. Red iron-ore.
   1. Red hæmatite.
   2. Compact red iron ore.
   3. Red iron-froth.
   4. Red iron-ochre.
4. Hydrate of iron.
   1. Stilpnosiderite.
   2. Brown hæmatite.
   3. Compact brown iron-stone.
   4. Brown iron-froth.
   5. Ochry brown iron-stone.

6. Globular hydrate.
   1. Lenticular.
   2. Kidney form.
   3. Pisiform.
7. Bog iron-ore.
   1. Morass-ore.
   2. Swamp-ore.
   3. Meadow-ore.
8. Umber.

FAMILY OF SALTS.

1. Carbonate.
   1. Crystallized.
   2. Fibrous.
   3. Clay ironstone.
      1. Common.
      2. Jaspery.
2. Phosphate.
   1. Crystallized.
   2. Earthy.
3. Arseniate.
4. Sulph-arseniate—(Pichy iron-ore.)
5. Skorodite.
6. Chromate.
7. Silicate.
   1. Yedenbergite.
   2. Yenite.
   3. Pyrosmalite.
   4. Knebelite.
8. Tungstate—(Wolfram.)
9. Sulphate.

10*th Genus.*—(*Manganese.*)

FAMILY OF OXYDES.

1. Gray Oxyde.
   1. Foliated.
   2. Radiated.
   3. Fibrous.
   4. Compact.
   5. Earthy.
2. Black oxyde.
3. Wad.
4. Sulphuretted oxyde.

FAMILY OF SALTS.

1. Phosphate.
2. Silicate.
   1. Compact.
   2. Foliated.
   3. Helvine.
3. Carbo-silicate.

11th *Genus.*—(*Uranium.*)

FAMILY OF OXYDES.

1. Pitch-ore.
2. Uran-ochre.
3. Uran-mica.

12*th Genus.*—(*Cerium.*)

FAMILY OF SALTS.

1. Silicate.
   1. Cerite.
   2. Allanite.
   3. Gadolinite.
   4. Orthite.
   5. Pyrorthite.
2. Fluate.
   1. Fluate of cerium.
   2. Subfluate.
   3. Yttrocerite.

13th *Genus.*—(*Tantalum.*)

FAMILY OF OXYDES.

1. Tantalite.
2. Yttrotantalite.

13th Genus.—(*Cobalt.*)

FAMILY OF ALLOYS.

1. White cobalt ore—(Tin-white cobalt-ore.)
2. Cobalt-glance — (Silver-white cobalt-ore.)
3. Gray cobalt-ore.

FAMILY OF SULPHURETS.

1. Cobalt pyrites.

FAMILY OF OXYDES.

1. Black cobalt ochre.
2. Brown cobalt ochre.
3. Yellow cobalt ochre.

FAMILY OF SALTS.

1. Arseniate.
2. Sulphate.

13th Genus.—(*Nickel.*)

FAMILY OF ALLOYS.

1. Native nickel.
2. Copper-nickel.
3. Glance-nickel.

FAMILY OF OXYDES.

1. Nickel ochre.

FAMILY OF SALTS.

1. Arseniate of nickel.

14th Genus.—(*Molybdenum.*)

FAMILY OF SULPHURETS.

1. Common sulphuret.

FAMILY OF OXYDES.

1. Molybdenum ochre.

15th Genus.—(*Tin.*)

FAMILY OF SULPHURETS.

1. Bell-metal ore, or tin pyrites.

FAMILY OF OXYDES.

1. Tinstone.
    1. Crystallized.
    2. Granular.
    3. Fibrous, or wood-tin.

16th Genus.—(*Titanium.*)

FAMILY OF OXYDES.

1. Rutile.
2. Anatase.
3. Menaccanite.
4. Iserine.
5. Nigrine.

FAMILY OF SALTS.

1. Sphēne.

17th Genus.—(*Zinc.*)

FAMILY OF SULPHURETS.

1. Blende.
    1. Yellow.
    2. Brown.
    3. Black.
    4. Fibrous

FAMILY OF OXYDES.

1. Red oxyde of zinc.

FAMILY OF SALTS.

1. Silicate — (electric calamine.)
2. Carbonate.
    1. Crystallized.
    2. Earthy.

18*th Genus.*—(*Bismuth.*)

FAMILY OF ALLOYS.

1. Native Bismuth.

FAMILY OF SULPHURETS.

1. Bismuth-glance.
2. Cupriferous bismuth-glance.
3. Plumbo-cupriferous, or needle-ore.

FAMILY OF OXYDES.

1. Bismuth ochre.

19*th Genus.*—(*Lead.*)

FAMILY OF ALLOYS.

1. Native lead.

FAMILY OF SULPHURETS.

1. Galena.
   1. Foliated.
   2. Steel grained.
2. Blue lead-ore.
3. Antimonial sulphuret.
4. Bournonite.
5. Arsenio-sulphuret.

FAMILY OF OXYDES.

1. Yellow oxyde.
2. Red oxyde.

FAMILY OF SALTS.

1. Carbonate of lead.
   1. Crystallized.
   2. Earthy.
2. Murio-carbonate.
3. Phosphate of lead.
   1. Green.
   2. Brown.
4. Arsenio-phosphate.
5. Chromate.
6. Sulphate.
7. Molybdate.
8. Arseniate.
9. Antimonial-arseniate.
10. Tungstate.
11. Aluminate.

20*th Genus.*—(*Antimony.*)

FAMILY OF ALLOYS.

1. Native antimony.

FAMILY OF SULPHURETS.

1. Gray antimony ore.
   1. Compact.
   2. Radiated.
   3. Fibrous.
   4. Plumose.
1. Nickeliferous gray antimony ore.

FAMILY OF OXYDES.

1. White Oxyde.
2. Red oxyde.
3. Antimony ochre.

21*st Genus.*—(*Arsenic.*)

FAMILY OF ALLOYS.

1. Native arsenic.

FAMILY OF SULPHURETS.

1. Orpiment.
   1. Realgar.
   2. Yellow orpiment.

FAMILY OF OXYDES.

1. Native Oxyde.

INFLAMMABLE CLASS.

1st Genus.—(Carbonaceous.)

DIAMOND FAMILY.

1. Diamond.

GRAPHITE FAMILY.

1. Mineral charcoal.
2. Graphite.
3. Glance-coal.

2d Genus.—(Bituminous.)

BITUMEN FAMILY.

1. Naphtha.
2. Petroleum.
3. Mineral pitch.
    1. Asphaltum.
    2. Elastic mineral pitch.
    3. Earthy mineral pitch.

COAL FAMILY.

1. Black coal.
    1. Jet.
    2. Cannel coal.
    3. Slate coal.
    4. Soot coal.
    5. Coarse coal.
2. Brown coal.
    1. Bituminous wood.
    2. Moor coal.

3d Genus.—(Resins.)

1. Amber.
2. Fossil-copal.
3. Retin-asphalt.

4th Genus.—(Sulphur.)

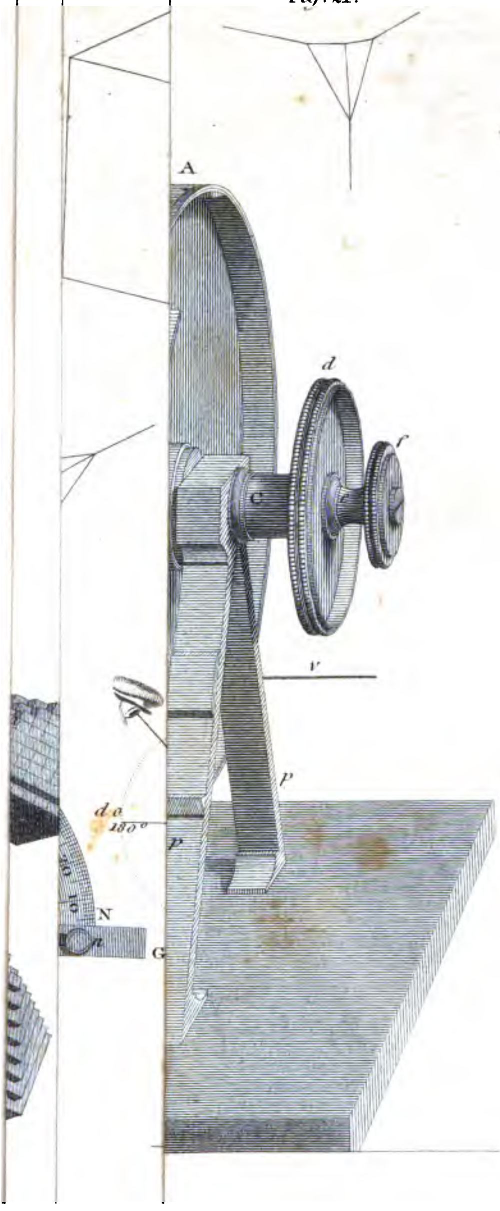
1. Native sulphur.
    1. Crystallized.
    2. Volcanic.

INDEX.

PLAT

Fig. 1.

Fig. 21.



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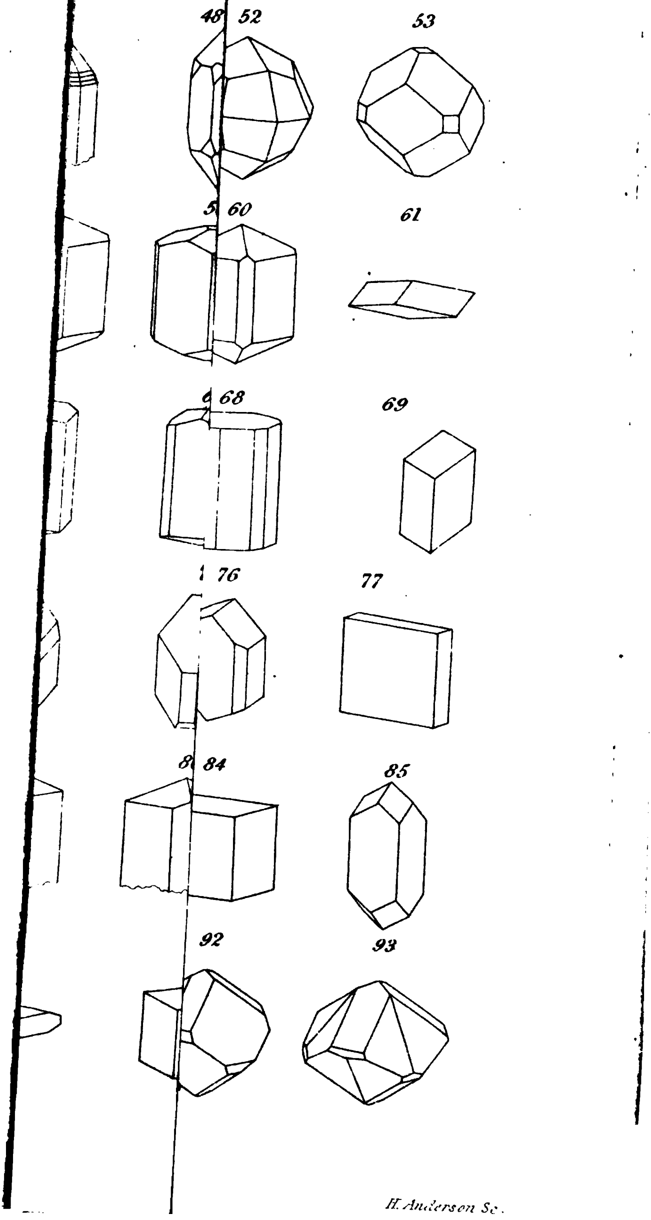

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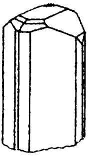
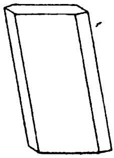
Pl. VI.

148



149



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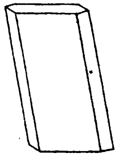

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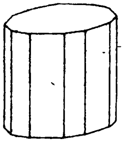

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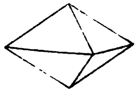

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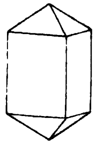
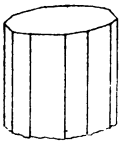


163



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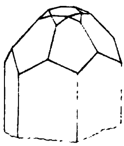

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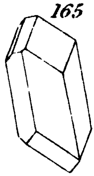
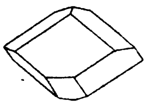
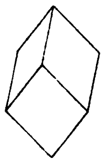


171



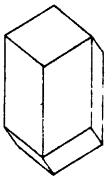
172

173

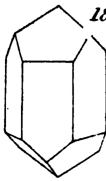


179

180



181



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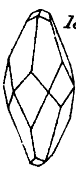

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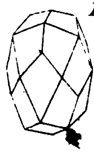

189

H. Anderson Sc.

Pl. VIII.

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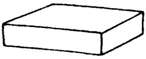

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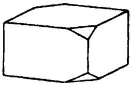

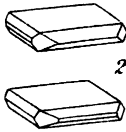
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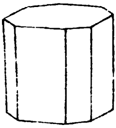

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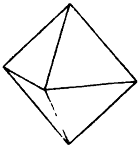

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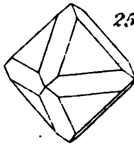

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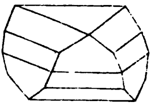

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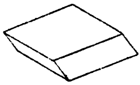

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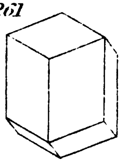

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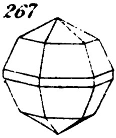

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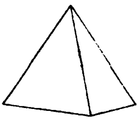

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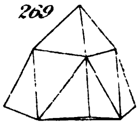

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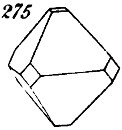

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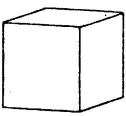

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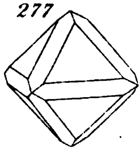

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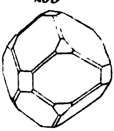

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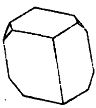

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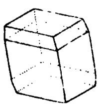
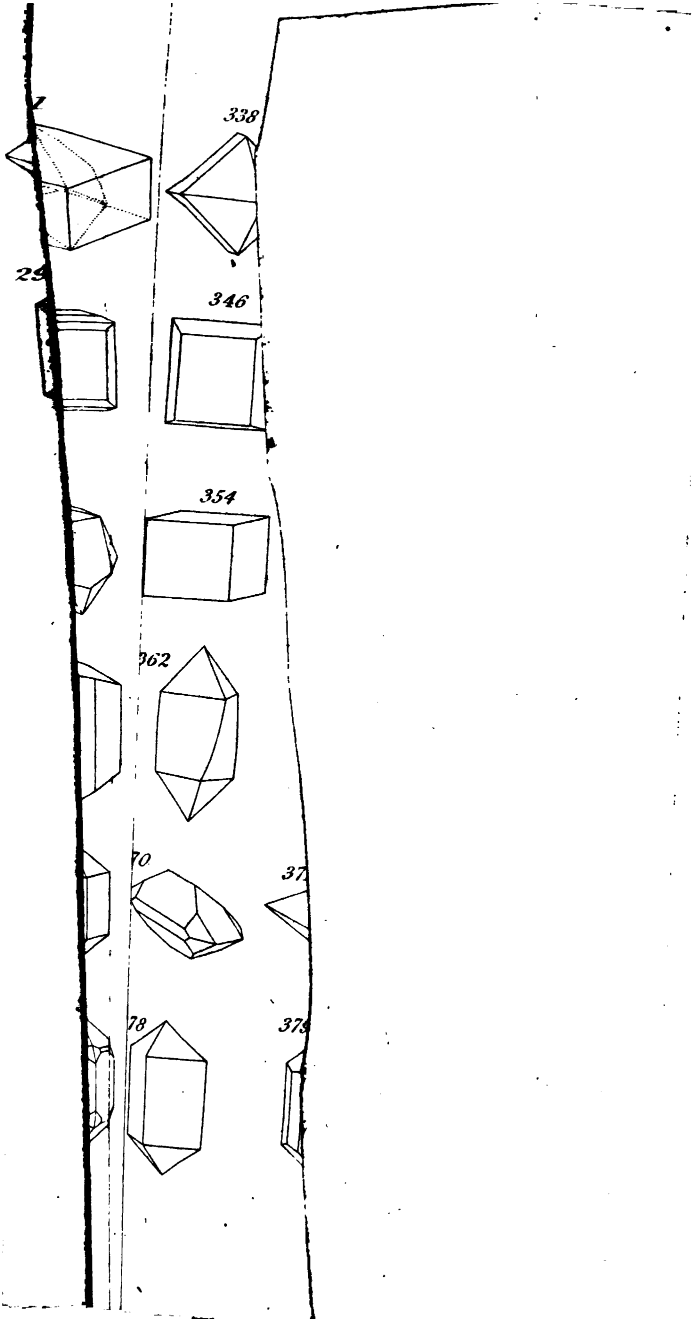


H. Anderson Sc.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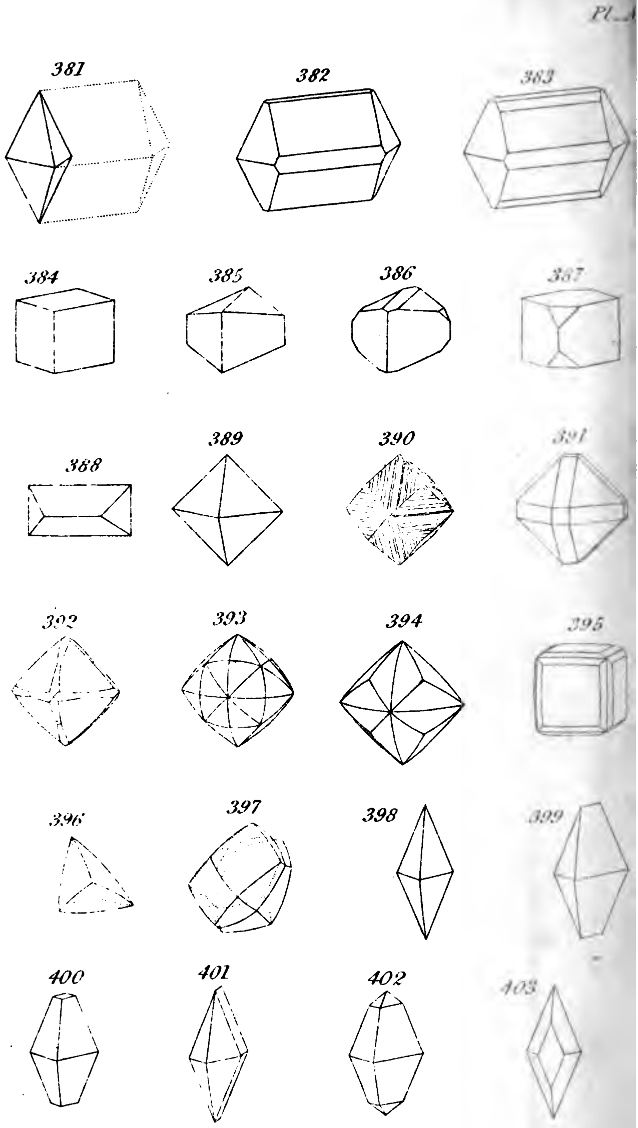
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